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ELECTRICAL ENGINEERING IN THE ROYAL NAVY

THE cover picture this month shows H.M.S. *Victorious*, veteran of wartime convoys to Russia, air actions against the *Bismarck* and *Tirpitz*, and the campaign in the Far East, which was rebuilt a couple of years ago and fitted with all the British-developed aids to naval flying.

The Foreword on p. 393 refers to the ship's three-dimensional radar system, weighing 27 tons, which can be seen on top of the 'island'. This 'giant dustbin', housing the transmitter, receiver and aerial, is more than 100 ft above the water and provides simultaneous information on the height, range and bearing of aircraft contacts. The electronic equipment on board H.M.S. *Victorious* cost over £1 million.

An action speed tactical teacher unit used by the Royal Navy is described on p. 398

Secretary W. K. BRASHER, C.B.E., M.A., M.I.E.E. *Editor* W. G. ASKEW, M.C.
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JOURNAL

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ROYAL NAVAL ELECTRICAL ENGINEERING

CHANGES in design in the last 20 years have given warships far more precise information about events around them, and far greater capacity for effective action against an enemy, than their predecessors had. The information available has been extended by the development of radar, asdic and communication systems, and the fighting power greatly strengthened by radar control, by improved fire-control equipment and guns, and by guided missiles.

These changes have been brought about by the use of all available engineering techniques, and many members will at some time or another have been involved in part of the work. The effect on ships has been to pack them comparatively densely with equipment, and this is responsible for the remark of a visiting don 'It was all very interesting, but there was nowhere to sit down'.

Electrical engineering problems are extremely numerous. In general they can be divided into three classes: the development of new ways of extending the capabilities of warships; the use of new ideas to do automatically, and better, things which used to be done by men; and techniques for increasing the reliability and ease of servicing and reducing the size of equipment. Developments on these lines occur simultaneously, of course. There is at the same time a tendency to try to solve electronically all sorts of problems which cannot be solved in any other way and an absolute determination to accept permanently no apparatus which is not very good indeed. Inevitably many of the solutions involve detailed work outside the scope of this Foreword.

The scope of the advances in electrical engineering is indicated by the increase in generating capacity in warships. In 1910 the largest ships had 600kW of capacity. By 1930 this had increased to 2300kW and by 1950 to 3750kW. The newest aircraft carriers now have 8000kW. The need to save space and weight has led inevitably to the use of alternating current in place of direct current, and this has also reduced maintenance somewhat. Air-cooling is now widely used, and special arrangements are made for removing large quantities of waste heat from hot spots.

As might be expected, power-distribution installations in warships are becoming increasingly complex because of the large number of electrical devices fitted in all parts. In large ships the distribution is water-tight below a certain level in the ship and on deck, and drip-proof elsewhere. Damage-control requirement demand alternative circuits, temporary or permanent, so that power can be fed to important equipment quickly after damage has been sustained and cable runs have been damaged or switchboards flooded. The difficulty of keeping all this equipment light in weight is always present.

The development of more-accurate radar sets, asdic sets, and weapons has stressed the problem of maintaining an artificial vertical, independent of the roll and pitch of the ship. The artificial vertical must also be independent of any acceleration, including the awful jerk which a wave can give a ship when it hits all along one side simultaneously. It must, at the same time, be extremely reliable, since the ship's weapons depend on it for their successful performance.

The development of an accurate vertical, or accurate fire-control computer, requires the electrical transmission of an angle accurate to a few seconds of arc from one part of the ship to another. A simple and reliable method of doing this has received much consideration.

Servo-engineering problems remain of great interest, from their original design and the achievement of stability, to design for reliability and ease of tuning in service. One servo problem in the Royal Navy involved the accurate positioning of an enormously heavy gun-mounting to within a few minutes of arc to follow a

high-speed target and at the same time compensate the gun for the roll and pitch of the ship. It had been thought that the inertia of this very heavy gun would assist the servo in its job of retaining the gun in position when the ship rolled. Experience showed that this theory was not altogether borne out in practice, partly because the ship, as seen by the gun, moved in a most erratic way. In fact, considerable power was sometimes necessary to keep the gun pointing in the same direction in space during a heavy roll and pitch.

Another servo problem successfully solved was the compensation for ship's roll of the 27-ton radar aerial in H.M.S. *Victorious*. This carries a very high wind-loading as a result of its size and its position on top of the island structure of the carrier.

Improvement in communication has been continuous over many years and has, of course, led to an increase in the number of communication channels in use simultaneously in a ship. Since it is not possible to separate receiving and transmitting sites, serious interference problems arise.

A recent installation involved the use of ten 1kW transmitters in a space the size of the smallest suburban back garden, and a receiving station, to continue this space fiction, in the suburban house alongside. Several radar sets have to be imagined on the roof of the house, with great power in their transmitted pulses. Extremely sensitive receivers had to be prevented from being jammed by both the radar and the communication transmitters. Only meticulous design and elaborate precautions prevented jamming of all the receivers. The effectiveness of the precautions taken was, in fact, quite surprising.

Because engineering cannot be separated from considerations of manning and training, one problem is shared by the Royal Navy and industry—how to train, in a reasonable length of time and at reasonable cost, the people who maintain complicated equipment.

'DIP. TECH.' GATHERS MOMENTUM

It is reported that the new 'Dip. Tech.' qualification has been warmly welcomed by technical colleges, by industry and by young men and women now on the educational ladder to scientific achievement. Its popularity is reflected in figures issued by the National Council for Technological Awards in their annual report, published recently.

There are now 95 recognized courses at 23 colleges leading to the award. Nearly 4000 students—including 84 women—have been enrolled. A total of 163 students, including one woman, have been awarded the Diploma, equal in standing to an honours degree of a university.

The report says the number of students attending the first year of courses continued to increase. The number now enrolled in the first year is 1558, against 1171 in March 1959. This total includes 40 women, and the National Council hope that the first award of the Diploma in Technology to a woman student last year 'will encourage more women to take up a career in the field of technology'.

Out of the total of students registered, the great majority (3442) are studying for the award by the sandwich-course method. The comparative figure in 1959 was 2323.

The National Council's report mentions the requirement that students following courses leading to the Diploma should be able to participate in a 'substantial' research project, and gives instances of the advanced work involved. In some cases, the projects are selected by the students themselves; in others, they are devised having regard to the particular interest of the student and any specialized equipment which may be available in the technical college concerned.

In one instance, work involving a comparison of measured and calculated vibration frequencies of sheet metal was carried out by means of a computer which the college possessed. In another case, a student's work on the thermal conductivity of powders involved developing a design theory for an instrument; the results were so successful that they are to be published by the student, jointly with his industrial supervisor. In some instances, industrial firms assisted students by providing equipment for experimental work to be carried out in the college.

In May 1959, the National Council established The College of Technologists, Membership of which constitutes an award higher than the Diploma in Technology and is stated to be broadly equivalent in standard to the Ph.D. degree of a university. By the end of March 1960, nine applications to register as candidates had been received. Five were registered as candidates for Membership; three other applications were still under consideration.

The National Council have always regarded a course leading to the Diploma in Technology as a complete entity, the industrial training being just as much a part of the course as the academic study. With their annual report they publish a memorandum setting out their requirements regarding the industrial training of students for the Diploma. The memorandum defines the responsibilities of firms providing industrial training and of colleges which the students attend, and outlines particular information about industrial training which will in future be required by the National Council before they recognize a course.

In the memorandum, the National Council for Technological Awards say that they asked colleges to supply details of the arrangements now operating, and found the information submitted both helpful and encouraging; they express their interest in the various ways in which colleges and industry are now collaborating over industrial training.

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Rural electrification in Ireland

The first pole of the rural-electrification scheme in the Republic of Ireland was erected in November 1946. Of the 400000 farms and rural dwellings in Ireland it was estimated that a supply could be offered at standard rates to 344000 (86%) and that, of these, 280000 (or 69% of the total) would, in the first instance, accept supply. At the end of December 1959, more than 250000 rural consumers had been connected.

The article reviews the place electricity now plays and can play in the future in helping the Irish farmer, and is based on part of the author's paper 'The place of electricity in Irish agriculture' which he read at a meeting of the Irish Branch on the 21st January 1960. Mr. Shiel is with the Electricity Supply Board, Ireland.

M. J. SHIEL, B.E., B.SC., ASSOCIATE MEMBER

BEFORE we examine the place electricity occupies in Irish farming, it is as well to point out some differences between conditions in Ireland and Britain. Table 1 compares the sizes of farms in the two countries; holdings of less than 5 acres are not included.

The most outstanding difference is the high proportion of farms in Ireland of under 50 acres. In the 'under 15 acres' category most of the Irish farms are operated at subsistence level, whereas in Britain presumably a large proportion of these would be classed as market gardens. Practically all Irish farms are 'owner-driven', the tenant system being almost unknown.

In the dairy districts, most of the milk goes for butter manufacture, as the relatively small urban population provides a poor market for liquid milk. By far the greatest farming activity is livestock production, as the climate is particularly suited to the growth of grass. Although there is a certain amount of specialization in various districts, it is safe to say that, in general, farming is carried out on a mixed basis.

Agriculture in Ireland produces about 25% of the national income as against about 6% in Britain.

The problem

Until now the general pattern of Irish farming has been one of low production with high production costs, with the consequent difficulty in competing in world markets. The low standard of living associated with farming in these conditions has caused a movement from the land on the part of the younger generation. The problem therefore facing Irish agriculture is how to retain the young and energetic on the land, and through them to build up a pattern of higher production and lower production costs. In both these objectives electricity can play an important part.

Table 1. Comparison of farm size in Britain and Ireland

size (acres)	Britain			Ireland		
	number of farms	% of total	% of farm area	number of farms	% of total	% of farm area
5–15	91000	25·8	3·5	59066	21·0	5·7
16–50	99000	28·0	15·5	146976	51·0	33·7
51–100	69900	20·0	22·0	52270	18·0	25·6
101–200	50160	14·6	29·0	21930	7·5	19·5
over 200	41420	11·6	30·0	7152	2·5	15·5

Electricity in the Irish farmhouse

The first move in improving the lot of the farming family is to improve living conditions in the farmhouse, and up to the present the greatest success of rural electrification has been in this sphere. The introduction of running water with the help of the electric pressure-storage water system is probably doing most of all to raise the rural standard of living, bringing as it does in its train the benefits of modern sanitation.

Table 2, compiled on the results of a recent survey, shows the saturation figures for some domestic appliances.

Rates of charge

In the normal farm, electricity tariffs are on a two-part basis. There is a fixed charge based on the floor area of the dwelling-house, and to a much lesser extent on the area of the outbuildings, and also a charge for the number of kilowatt-hours consumed. For a house with a floor area of 1150ft² with outbuildings of 2000ft², for example, the fixed charge is £1 5s. per two-monthly period. The first 80kWh used in the period costs 2·8d. per kWh, the next 280, 1·5d., and the remainder, 1·1d.

Electricity for all normal domestic and farm applications, including motors not exceeding 3h.p., is supplied through the one meter, thus simplifying the wiring problem and enabling early advantage to be taken of the lower-priced blocks in the tariff scale.

The farmyard

While the growth in utilization of electricity in the farmhouse is encouraging, its application as a direct aid in farm production is developing at a much slower pace. The main reason for this is lack of capital, but in many

Table 2. Domestic electrical appliances in use in rural areas in 1958

appliance	number	% saturation
irons	149660	68·0
kettles	86580	39·3
space heaters	80390	36·5
cookers (full size)	34590	15·7
washing machines	25230	11·4
vacuum cleaners	19290	8·8
boiling-rings	19110	8·7
water heaters	8840	4·0
refrigerators	8780	4·0
toasters	6050	2·7
breakfast cookers	5650	2·6
wash boilers	5580	2·5

(Number of rural consumers at the time of survey was 220000)

cases it is due to traditional conservatism or a lack of conviction as to the benefits to be derived.

However, progress is being made along certain lines. The general pattern is that low-cost applications such as farmyard lighting and infra-red heaters for pig and poultry rearing receive first priority, with the more expensive appliances following—in some cases a long way behind. At present these latter are confined mainly to the larger farms. Nevertheless there are grounds for believing that this situation will improve in the near future. In nearly every country, development of electricity in the farmyard has been via the farmhouse.

Table 3, based on the same survey as Table 2, gives the present picture.

Running water

The provision of running water by means of an automatic pressure-storage water system is an exception to the general rule of the more expensive appliances being confined to the larger farms. One reason is that a plentiful supply of water on tap is appreciated even more in the home than on the farm, while another is the availability of Government grants for this purpose. Although the proportion of farms with electric pumps is still small (about 13%), there are strong indications that this number will increase rapidly in the future.

Until now most of the installations have been on the basis of a separate source and pumping system for each farm. Several communal systems have been recently installed, where a single source, pump and pressure-tank supply a group of farms. The success attending these installations, particularly from the cost point of view, indicates that this method of water supply will become very popular within a short period.

Table 3. Electrical farm appliances in use in rural areas in 1958

appliance	number of farms	% saturation*
infra-red lamps and heaters	26460	19·2
pumps	17430	12·6
milking machines	8310	6·1
water heaters	6240	4·5
electric motors	4530	3·3
grain grinders	3400	2·5
churns	690	—
welders	560	—
milk coolers	420	—
grain dryers	350	—

* Percentage saturation figures are not of much significance in the case of agricultural appliances, as the potential market for these varies considerably with the size of farm, the locality and the type of farming carried out

Motive power

Owing to the comparatively slender resources of the country, it was most important to keep the capital cost of the rural-electrification networks to the minimum consistent with good standards. As a result, single-phase distribution was adopted as standard, although, where a particular load warrants it, 3-phase supply can be made available. Nominal voltage is 220, and, while in many cases the standard British 240volt motors operate satisfactorily, it has been found desirable to specify 200–220volt windings for general use.

Where motors larger than the fractional-horse-power type are installed any appreciable distance from the transformer, a starter which allows the overload and no-volt coils to be cut out manually during the starting period is advocated.

1 *A small 'do-it-yourself' tray-type grain dryer*
The heater and fan are mounted under the floor at the right-hand end

Crop drying

The use of the combine harvester has spread very rapidly through Irish farming, bringing with it the problem of grain drying. The number of farm dryers has not spread at anything like the same rate. A low-cost tray-type electric dryer has been developed which the farmer can install on the 'do-it-yourself' principle at a total cost ranging from about £70 for a 5kW unit (1 ton per day for 6% reduction in moisture content) to about £130 for a 15kW dryer (3 tons per day). Fig. 1 shows a typical installation of this type of dryer with the fan and heater mounted underneath the floor of the loft.

Owing to the poor load factor of such driers, efforts are now being made to combine grain drying with barn hay drying so as to extend the useful working period. This application is in its infancy, as only a few of these combined units have been installed.

Transformer and l.v. mains capacity is the chief deterrent to the use of dryers larger than those mentioned. With this in mind, experiments are currently in progress in the development of a mobile high-capacity dryer, capable of being directly connected to the 10 kV single-phase overhead lines which pass over most farms in the grain-growing areas. This dryer, which is a trailer-mounted tray type, has a built-in 100 kVA 10 kV/220 volt transformer with a special arrangement of h.v. feed designed for live-line connection. Fig. 2 shows the prototype undergoing field tests.

Grain handling

The average Irish farmer cannot afford the more expensive conveying and handling equipment suited to the large farm. The auger elevator, however, with its low first cost and low running costs, appears made to measure for his modest grain-handling problems, particularly as in the off-season the motor can be detached and used for other purposes. As yet the number of these appliances is in the low hundreds.

Food preparation

The use of home grinders is spreading rapidly as farmers become aware of the time and labour thereby saved. An especially popular model is a 1 h.p. stone mill with an output of about 1 cwt (medium grind) per hour. A 1½ h.p. hammer mill with a somewhat greater output has recently been introduced. Hammer mills in the 3 h.p. range are mostly confined to the larger farms.

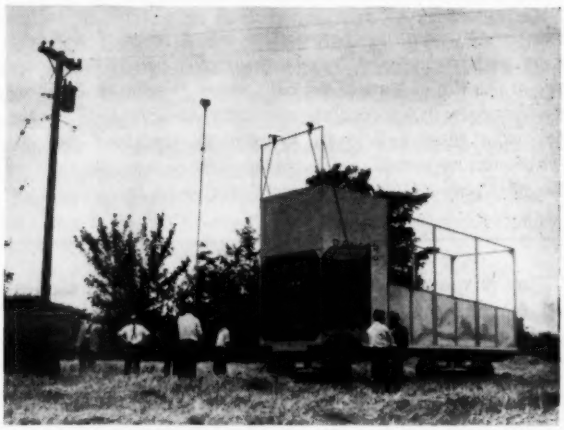
Food mixers have not yet become popular, probably owing to their comparatively high price.

Dairy farming

In the dairy areas the milking machine was widely used even before the advent of electricity. Existing machines are now being rapidly converted to electric drive, and in addition large numbers of new electric machines are being installed. As the market for liquid milk is comparatively small, milk cooling is not as widespread as in a more industrialized country. Similarly, as all milk for butter production is pasteurized at the creamery, the development of the use of electricity for steam-sterilizing on the farm is restricted.

Other applications

In pig and poultry rearing, the advantages of the infra-red lamp and heater are widely recognized. Electrical floor-warming for stock is not very popular. In horticulture, electricity is becoming important in providing accurate control of heating systems and in the direct provision of heat for the frost protection of glasshouses and frames. Soil-warming has been introduced successfully, and there are a number of mist-propagation installations which are proving very successful.



2 *Testing the 10 kV connection arrangements of the experimental mobile grain dryer*

Summary

With almost 90% of the original rural-electrification scheme completed, electricity has come to take a definite place in Irish agriculture. Its adoption in the rural home has been more rapid than on the farm. The Irish farmer is, however, now more aware of the help which electricity offers in his quest for increased and more economic production, and it is expected that the coming years will see a considerable expansion of farm electrification in Ireland.

ANGLO-FRENCH RADIO LINK

THE telephone service between Britain and the Continent should be even more efficient by the end of 1960 when the first stage of the new Anglo-French radio link—of which the Eurovision television link is part—is introduced.

Eventually this link will add another 600 public-telephone circuits to the 273 now in use to the Continent. Although 1960 will see an addition of only some 122 circuits—48 to Rome in time for the Olympic Games there, 24 to Paris and 50 to Zürich—more will be brought into use as the dialling system between London operators and Continental subscribers is increased.

Continental Exchange operators can at present dial subscribers' numbers in Belgium, Denmark, Germany, the Netherlands and Switzerland: by the end of 1960 it is hoped that this will be extended to Austria, Italy and Sweden and in 1961 to Finland and Spain as well.

The new radio link will provide many more circuits than is possible by the present submarine cables crossing the Channel. Although the existing cables will still be used, they are liable to damage in shallow waters, and the radio link will provide an alternative when this occurs.

ACTION SPEED TACTICAL TEACHER

373.63 : 355.46 : 621.389

The most recent of the action speed tactical teachers employed by the Royal Navy was installed nearly four years ago at the Royal Naval Tactical School, Woolwich, London, and has been in use continuously since January 1957. In the following short article its function is explained and the techniques employed are discussed, with some comments on the problems of keeping the facilities up to date.

THE purposes served by the latest action speed tactical teacher are the training of officers in naval tactics and in the application of tactical doctrines in warfare at sea, and the investigation and evaluation of new tactics. A succession of courses of from three to ten weeks' duration is held at the Tactical School throughout the year, and students include officers of the Royal Navy and Royal Air Force and of Commonwealth, N.A.T.O. and foreign navies.

The teacher in use

A total of 16 independent ships, of which five may be submarines, are each simulated by an 'operations room' manned by the Commanding Officer and his staff and supplied continuously with all the information that would be available to the ship at sea, including navigational plot, radar display, sonar and radio information and communication. The Commanding Officer controls the course and speed of his own ship and can order the firing of weapons. In the case of aircraft carriers he can control and direct associated aircraft. A total of 12 independent aircraft are simulated, each of which can represent a group of aircraft. Ships, submarines and aircraft can be grouped into Red and Blue forces in any proportions for particular exercises, and a convoy of any size is also represented.

While the individual ships are aware only of the local situation about them, the complete geographical location of all the craft, including submerged submarines, is displayed by means of projectors on a screen in the auditorium in front of the directing staff, who are also provided with information on courses and speeds of ships and aircraft and have facilities for monitoring all communications.

By means of scale-changing gears, the area displayed on the screen and over which the exercise is played can be altered from a minimum of 25 miles square for manoeuvring practice and anti-submarine exercises to a maximum of 1600 miles square for exercises of a more strategical nature. For exercises over the larger areas, a 'blown-up' view of a 50- or 100-mile square anywhere in the exercise area is provided on a second display screen alongside the main screen. Throughout the game the position of each craft is plotted by crayon on a Perspex screen behind the cloth display screen, and at the end the cloth screen can be rolled up and the tracks displayed by edge lighting of the Perspex screen.

Techniques

In designing this installation the aim was reliability with low maintenance. Mechanical or electro-mechanical techniques were adopted wherever practicable, and a somewhat unrealistic radar simulation, which was however fully adequate to provide information for tactical purposes, was adopted for reasons of simplicity and economy. This latter point will be appreciated when it is realized that there are 28 radar displays, each about a different centre, displaying up to 48 targets on each, any target being displayed only when within normal radar range of the observer.

Cartesian co-ordinates are used as the basis, and the movements of all craft are resolved into northings and eastings which are transmitted by Admiralty M-type step-by-step transmission, each step being 50 yd. This form of transmission was adopted because it gives reasonable power directly at the receiver motor without the need for a servomotor. Power is required to operate both the precision projectors and the scale-changing units with potentiometer drives. This transmission is not of course self-synchronous, so a synchro link with indicators is fitted in part of the system for visual checking, particularly when setting up.

The auditorium seen from the projector platform, showing display screens and control position

Foreground: weapon umpires' console. Front row (left to right): aircraft controller; second controller; electronic counter-measures controller; first controller; teller; and communications grouping cabinet

The synthetic radar display system is based on the principle of 'painting' targets consecutively, which was

adopted for earlier tactical teachers. Much greater scope and precision were required than formerly, and the detailed technique was necessarily quite different. The system has to cope with an exercise area 1600 miles square and to provide P.P.I. displays of 10 miles' radius at the most open scale, i.e. with precision to 0·1 mile.

A.C. system

The system adopted was a 2-phase 2kc/s system with one phase concerned with northerly co-ordinates and the other with easterly. The position of each craft is reproduced, in the scale-changing units, as the position of a slider brush on a helical potentiometer for each co-ordinate. The potentiometers are energized from the a.c. supply on the basis of 40mV/mile, i.e. 64 volts total for 1600 miles.

These supplies are 'floating', and as the sliders of each target are earthed in turn the sliders of every other craft have potentials to earth which are a measure of the difference of the co-ordinates of the target from the co-ordinates of the other craft. In other words, as each target is selected for earthing, its position in relation to each other craft is defined by the slider potentials to earth of the other craft. The earthing of the sliders in turn is effected by means of a pair of standard Post Office uniselectors stepping in succession at 25 steps/sec, so that the total of 48 targets is covered every 2sec.

The slider potentials to earth, or 'signals', are passed to the radar display outfit of the craft and are used to deflect the beam of the cathode-ray display tube. A pulse to the grid then produces a 'paint' of the target on the face of the tube in its true relative position. The pulse is inhibited if the target is out of radar range.

Stray capacitances

It was appreciated at the outset that an a.c. system of this nature would be liable to errors due to stray capacitances. For this reason the leads between the potentiometer sliders and the uniselector unit were kept short and the effective capacitance of each lead was reduced by maintaining the potential of the outer conductor of the coaxial cable close to that of the core by means of cathode-follower circuits.

The capacitance to earth of the supply transformer is even more important, since the supply is floating, and so screen windings were applied on either side of the single-layer secondary and maintained closely equal in potential to the secondary all along its length, again by cathode-follower circuits. This unusual adaptation of the guard-ring technique proved quite helpful.

Performance

The whole of the equipment—apart from incorporated components—was designed specifically for this installation and was put into manufacture without exhaustive tests or endurance trials. The synthetic radar outfit was installed without prior tests as a complete system. As a consequence there was a fair amount of 'teething trouble', but this was overcome in the first few months and since then the equipment has been reliable.

Some 250 students attend courses at the School each year and are emphatically agreed on the value of the installation, giving as it does training in manoeuvring and ship handling, in plotting techniques, in communication procedure and in control of aircraft, as well as practice in making quick decisions in rapidly changing tactical situations. The a.s.t.t. cannot replace training at sea, but its use greatly enhances the benefits obtained from subsequent exercises at sea.

The capital cost of the installation, amortized over five years, works out at about £5 per student per day, which cannot be considered high.

Future

Advances in weapons and detection devices involve changes in tactics and hence in the facilities to be provided in a tactical teacher. Often new requirements can be met by some adaptation of the existing equipment, and the operating staff have shown great ingenuity in this. In time these expedients are found inadequate or uneconomical, and then requirements are put forward for additional facilities to be incorporated. A few of the more urgent improvements have been made, but the heavy programme of utilization means that opportunities for carrying out modifications are few and brief.

This gives emphasis to the view that modification should be kept to a minimum and that a new teacher should be built to replace the previous one after some five years' use. The technological advances in this period can make this course economical, as well as highly desirable for maintaining instructional training without a break.

Conclusion

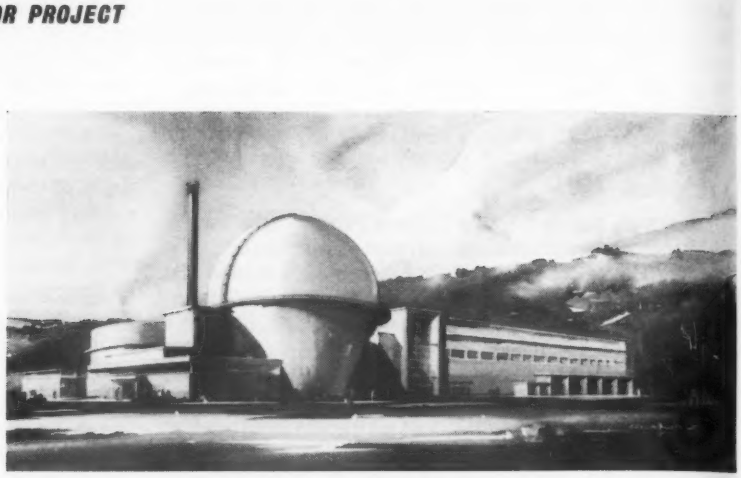
The department of the Admiralty which was responsible for the whole of the technical development of action speed tactical teachers from their inception had no laboratory facilities for this development, which was carried out by contractors under its direction.

The very satisfactory performance of these trainers and the very low incidence of failure in use reflect great credit on the contractors concerned and on the officers of the Royal Naval Scientific Service who directed the development.

New power stations for Yorkshire?

As part of the continuing process of seeking possible sites for new power stations, the Central Electricity Generating Board will be investigating six areas in the West Riding of Yorkshire to explore their suitability for large coal-fired stations. Sites adjoining the existing power stations at Ferrybridge and the new station under construction at Thorpe Marsh and four new areas at Knottingley, Kellingley, Eggborough and Gowdall will be examined. The investigations, expected to take several months, will include trial borings to verify the subsoil conditions. (See also p. 435.)

Windscale 1960



Artist's impression of the A.G.R. station after completion in April 1961

From the shadows of the two futuristic towers which now guard the mausolea of the first Windscale nuclear reactors rises a great steel pear, buried head-down in the Cumberland earth. Over 134ft high and 135ft in diameter at its widest point, this vast shell contains the first advanced gas-cooled nuclear reactor built to drive turbo-alternators.

Its two dead neighbours, still radioactive but sealed completely, served 70% of their designed life and yielded the data on which the British civil stations were designed. From the limitations of the dead arose this new concept, smaller and more efficient, yet so much safer that it could, if desired, be sited much nearer the load centres than was hitherto thought possible. The advances which have been made in the intervening design decade may be gauged from the fact that, size for size, a new gas-cooled reactor will produce six times the power of the Calder Hall type and operate at a temperature permitting a 30% increase in steam-cycle efficiency.

Because the Windscale A.G.R. is still essentially an experiment and thus has many duties in addition to boiling water, its over-all efficiency is only 27·3%; but the United Kingdom Atomic Energy Authority are convinced that civil power stations based on this reactor will be as efficient as, or more efficient than, comparably dated pulverized-fuel-fired generators this side of 1970, with generation costs below ½d. per kilowatt-hour sent out.

A.G.R. differences

Although the Windscale A.G.R. cost £9000000, this is less than the cost of other comparable nuclear stations; and because it differs little—other than in the fuel element—from current power reactors, it can readily be introduced into the current British nuclear-power programme. Studies confirm that it offers the best prospect of the early achievement of competitive nuclear power in Britain, and a similar station is now under construction in the United States as a result of extensive exchanges of information.

The important differences between the A.G.R. and its predecessors, which provide its increased efficiency, are:

(a) The fuel-element lattice is triangular instead of square

(b) The fuel is enriched uranium oxide instead of natural uranium metal

(c) The fuel element is a cluster of pencils instead of a solid rod

(d) The canning material is beryllium or stainless steel instead of magnesium.

These advances permit the maximum fuel rating to be increased from the 3MW/tonne used at Calder Hall to 19·5MW/tonne, and a doubling of the exit temperature of the carbon dioxide coolant fed to the four heat exchangers within the reactor housing to generate steam—which will thus be of much higher grade than hitherto possible. This in turn allows the adoption of a more modern turbo-alternator, and it is predicted that an optimized power-producing A.G.R. station will have an over-all net efficiency of 38%.

Beyond the reactor building, the Windscale A.G.R. project is essentially a normal single-set generating station, with a 33MW 11·5kV alternator driven by a 650lb/in.^{2} 850°F turbine. The effect of reactor steam supply is, however, seen in the provision of a dump condenser capable of absorbing the full steam output, since a reactor cannot be shut down as rapidly as a normal boiler; and the nature of the electrical needs of Windscale as a nuclear-experiment establishment, which involves 100% reliable supplies, is reflected in the provision of high-power Diesel standby engines.

Where the project differs markedly from conventional modern practice is in the provision of blast walls: the switchgear bay, adjacent to the turbine hall as usual, is separated by a full-height reinforced concrete wall, while the control room lies behind another full-height concrete wall additionally reinforced by a ⅜in. steel-plate shield. These precautions are

not so much a particular feature of nuclear-station design as a legacy from the Calder Hall incident, when a turbine ran away and exploded—an event overshadowed by the Windscale nuclear accident, involving the discharge of fission products, of the previous year.

Furthermore, the steam-control system is duplicated to avoid a repetition of this turbine trouble.

This, then, is the Windscale A.G.R. as a power station connected to the Grid. But because it is, to the Authority, essentially an experimental plant, there is within the station buildings a network of fuel-element examination caves for the provision of data on discharged fuel elements from the A.G.R. and other reactors.

Other experiments

Finally, developing alongside this project and housed in some of the usable buildings of the defunct Windscale piles, are a series of experimental reactors designed to facilitate operation of the A.G.R. types as a family. They include a fine-structure stack to investigate neutron-flux distribution within the fuel elements and their constituent pencils (among other things); a flexible 'approach to critical' stack which allows the lattice pattern to be changed and permits controlled reactivity measurements as criticality is approached; and an equally flexible exponential stack using natural-uranium fuel.

Dominating these is Hero—the 'hot experimental reactor, zero energy'—a flexible reactor experiment in which the temperature is controlled by electrically heating the carbon dioxide coolant (the reactor generates only about 1 kW of heat). The graphite core and enriched uranium oxide fuel elements are similar to those of the A.G.R., but allow investigation of the effects of rearranging the fuel-element pattern and pitch and the temperature difference between the fuel and the core.

The reactor will thus provide data, easily and cheaply, on a wide variety of operating conditions in gas-cooled reactors, and therefore greatly assist their development.

Thus Windscale establishes its tradition: the Calder Hall stations set the pattern for the current generation of nuclear power stations; the A.G.R. now begins the second generation of greater-efficiency compact stations, and will be developed steadily until, in perhaps another decade, technological advances will see the high-temperature gas-cooled reactor operating in conjunction with the most modern high-temperature high-pressure turbo-alternators available.

D.S.I.R. grants for research

In 1959, the Department of Scientific and Industrial Research increased the number of grants to universities and technical colleges for researches in every field of science except mathematics. Details of grants for nuclear physics and radio astronomy are given below as an indication of the research now being undertaken in the universities with the support of the D.S.I.R.

Nuclear physics

During the year, the Department made a grant of £400000 to meet the cost of a horizontal Van de Graaff electrostatic generator for research in low-energy physics at the Nuclear Physics Research Laboratory, University of Liverpool. No horizontal machines have been built in this country, and, so that research may begin at Liverpool as quickly as possible, a 10 MeV tandem machine of a type already used and tested elsewhere is required.

Radio astronomy

In addition to continued support for the Manchester University Group at Jodrell Bank with three grants totalling £187000, the D.S.I.R. has awarded nearly £40000 to Prof. M. Ryle for the development of new techniques and equipment at Cambridge University. The Cambridge interferometer consists of fixed and moving aerials, capable of studying faint radio stars and the cosmos at immense distances.

The work will mainly be aimed at new methods of constructing and improving radio telescopes and new automatic systems of data recording for automatic computation.

ISOTOPE INFORMATION BUREAU

To provide a convenient central point of inquiry for anyone seeking information on the production and uses of radio-isotopes, the United Kingdom Atomic Energy Authority have set up the Isotope Information Bureau at their London office.

It will be of particular interest to managers, plant designers and production staff of those industries which have previously had little or no association with atomic energy but which nevertheless may reduce considerably their manufacturing costs by the application of radio-isotopes to their factory processes.

Window display

Since the development of radio-isotope use is comparatively new and consequently its techniques and practices are not widely known, material has been displayed in the windows of the Bureau explaining in non-technical terms what radio-isotopes are, why they are made, and their principles of operation when applied to industrial processes. Within the Bureau, a non-technical exhibition describes the methods of packaging and distributing radio-isotopes and shows examples of their use in industry. In addition, a compact projector has been installed, with which a short film can be shown to visitors, describing actual radio-isotope industrial applications.

The staff in attendance are able, with these aids, to provide visitors with a basic introduction to the industrial uses of radio-isotopes, to specify reference works for study by those with further interests, and to place inquirers in touch with the appropriate departments of the Authority in those cases where detailed information is being sought.

Annual General Meeting of The Institution, 1960

THE PRESIDENT, Sir Willis Jackson, D.SC., F.R.S., took the chair at the 88th Annual General Meeting of The Institution at 5.30 p.m. on the 19th May 1960 at Savoy Place. The following list of donors to the Library for the year ended the 31st December 1959 was taken as read:

S. W. Amos
F. A. Benson
R. S. H. Boulding
H. Cotton
O. H. Davie
H. M. Dowsett
G. W. A. Dummer
J. W. Freebody
M. R. Gavin
R. A. Greenfield
D. Harrison
J. E. Houldin
Sir Willis Jackson
A. H. Morton
W. E. Pannett
G. Parr
D. P. Sayers
J. Shepherd
L. F. Spence
S. A. Stigant
E. Openshaw Taylor

The President, introducing the Annual Report (p. 404), said that the net increase in membership of all classes of 1678 had only once been exceeded during the past ten years. The upward trend of Student membership had been maintained. He spoke of Prof. M. G. Say's 1959–60 Faraday Lecture as a magnificent achievement.

Sir Willis paid tribute to the enthusiasm and vitality in the local Centres and Sub-Centres. He also referred to the search being made by the three major engineering institutions for means of achieving closer collaboration in matters of national, international and common importance. Turning to education, he remarked that The Institution's Training Regulations emphasized the merit and desirability of participation in formally organized schemes of training, but also made important provision for acceptance, in lieu of formal apprenticeship, of training in staff positions in appropriate cases. The Joint Committee on Practical Training had just completed the draft of a revised form of the 1957 Report on graduate training. He believed that the electrical industry continued to set a standard in industrial training, which he only wished other branches of British industry would seek more vigorously to follow. The dearth of good training facilities within British industry might well be the Achilles' heel of the developing arrangements for the improvement of technical and technological education.

In the June 1959 Part III Examination, the number of subjects entered had been 787 and the passes 321, a percentage pass of about 41. In the December 1959 Part III Examination, the subject entries had been 279 and the passes 173, a pass average of 62%. This improvement indicated that the colleges conducting approved preparatory courses for the Part III Examination were rapidly acquiring greater familiarity with the scope of the subjects and the standards required.

The Council were nevertheless aware that the introduction of the Part III requirements had raised difficulties for some National Certificate candidates of good ability who were prevented by either domestic or industrial circumstances from attending appropriate preparatory courses for the Part III Examination, and this was receiving active consideration by a sub-committee, which was also further studying the part which The Institution might play in resolving the difficult problems associated with electrical technicians.

The volume of correspondence published in the *Journal* had increased, but the Council and the Papers Committee hoped that this channel of communication between members would continue to grow and to strengthen.

Section G was a new departure in the form of the Report. It introduced the 1959 Annual Accounts, which now allocated outgoings to particular items of The Institution's activity. It was hoped this would be helpful to members.

The President proposed and **Mr. C. S. Briggs** seconded the reception and adoption of the Annual Report.

Mr. L. W. Phillips advocated the admission of the Press to the Annual General Meeting. He welcomed the reports of Council work in the *Journal*, and hoped these would sometimes say what the Council was going to do, not just what it had done.

There were 73 women members, and the Council should consider having a woman representative on the Council. He thought also that arrangements should be made so that members could get coffee and a sandwich at Savoy Place.

He deprecated the idea that membership should be restricted on an educational basis, but his main theme was moral and spiritual responsibility. The world was in a terrible state, largely owing to the technologist, who had to take responsibility for the changes he had produced in the social and educational life of the community.

'We dump a nuclear power station where we think we will, without any respect or regard for beauty and natural amenities. We have transmission lines going over the country, and we do not care two pins whether they spoil the outlook or not. We have had communications, electronics, television and radio; they have affected the habits of the community and the moral standard very considerably in a downward direction; and we technologists are responsible. We put technical achievement as the first and most desirable thing in life. We worship false gods. If we go on doing that, then naturally we are damned.

'After all, when we think that people with possessions are more important than character, when by our method of manufacture and our salesmanship we force people to take things, when we put manufacture in place of culture of the arts and crafts, how can we give a lead to get out of this desperate situation? First of all I think we ought to set up a new professional standard, a standard of conduct in relation to God and our fellows. What good is it if we throw out objects into space and forget the One who brought the universe into being and keeps the stars in their courses?'

Mr. P. N. Wyke asked for an assurance that the report of the Special Advisory Committee, when completed, would be available for inspection by the general body of members.

The President assured members that the recommendations of the Committee would be made known to them.

Mr. O. W. Humphreys, Chairman of the Special Advisory Committee and of the Papers Committee, then gave some details of the work of the Special Advisory Committee, about which **Mr. R. A. Laws** had asked earlier in the meeting. He had been helping to guide what had proved to be a most interesting and instructive exercise. It might have been a painful one, but he was glad to say it had not been.

'We started off by having a look at the events of last summer, exploring their causes and so on. Particularly, of course, we tried to think how we could stop the same thing happening again.

'Then we examined the general question of the government of The Institution. That is a thing of which one needs to take stock at intervals. We studied the constitution of the Council and the method of election to it. We considered the way in which the Council discharges its responsibilities.

'We reviewed the staffing of The Institution. Some comments

have been made about the efficiency and so on of our administration. I am very pleased to say that, after a very critical examination, we came to the conclusion that the Council is well served by an overworked and not over-rewarded staff.

'We have gone deeply into the *Journal* and the *Proceedings*. We had a lot of suggestions, mutually self-cancelling, concerning what we should do to the *Journal*! So we had to make up our own minds.

'We have scrutinized a number of important membership matters, such as the qualification for admission to Corporate membership, the procedure for transfer from Associate Membership to full Membership, why we have a large number of Associate Members who qualify for full Membership but do not apply, and the provision for the admission of electronics engineers when they come up the physics ladder. We shall in due course be making some recommendations.

'Finally, we have had a good look at the responsibility of members. It is all very well to calculate the responsibility of the Council, but even those of us who are members of the Council are also members. We have sought to advise members on ways in which they can put more into The Institution, because we believe it is by putting more in that they will get most out of it.'

Mr. P. E. M. Sharp referred to the plan for an engineering centre, which at one time had been on the agenda of the three presidents of the engineering institutions. With all the conventions, conferences, etc. which were taking place, he wondered whether the plan had been dropped.

The Immediate Past-President, **Mr. S. E. Goodall,** recalled that those negotiations broke down, which had been the reason for the rebuilding at Savoy Place. 'Had there been an alternative plan—and we actually held up this scheme because we hoped it might mature—we should certainly not have spent the vast sum of money on the building here.'

Mr. Laws talked about correspondence in the *Journal* and asked for the acceptance of letters critical of Council policy.

'Let the Council be just a little more "bloody, bold, and resolute", and not care what people say. Let them say a bit more about what they are doing.'

Mr. Humphreys said that, so far as correspondence in the *Journal* was concerned, he completely agreed; the Special Advisory Committee completely agreed; the Papers Committee completely agreed; and he was absolutely sure the Council completely agreed.

'We have to limit the amount of correspondence obviously, as we are limited by the number of pages, but the Papers Committee have told the Editor that they want him to be—"bloody, bold, and resolute", I am not quite sure—but in any case we believe we shall be doing good for The Institution by opening the correspondence columns to matters of general interest to The Institution, to its general well-being as well as to scientific matters. We also want to raise the status of the correspondence columns from the scientific point of view.'

The motion for the reception and adoption of the Annual Report was carried unanimously. The President then presented the Statement of Accounts for the year ended 31st December 1959 and moved that the Accounts be received and adopted. The motion was seconded by Mr. R. J. Rennie.

Mr. P. N. Wyke, noting that the *Journal* and *Proceedings* income from sales and advertisements had increased by about £3000 in 1959, asked whether it was anticipated that there would be a further substantial increase in 1960. He thought that the salary figures for each department would be more meaningful if the number of people in each department were also given in future.

The salaries, wages and national insurance amounted to £101 000. The salaries charged to departments came to £63 500, leaving in round figures £37 000. Since so many departments had been covered in 'Salaries charged to departments', he was intrigued to know what the remaining £37 000 represented.

Mr. C. T. Melling, Chairman of the Finance Committee, gave an affirmative answer to Mr. Wyke's first question. To obtain greater economy, arrangements were being made for the advertising to be handled within The Institution, instead of having it done by an outside agency, to whom a fee had to be paid.

The £37 000 represented the cost of these activities: Secretarial, Central Office, typing, filing, accounts, and subscriptions. The last took £5540, which seemed rather a staggering figure, but there was a good deal of chasing of subscriptions not paid on time.

Mr. J. K. Webb referred to the summary in par. 75 of how each £1 of membership subscription received in 1959 had been expended. He could not reconcile the ½d. excess of income over expenditure with the £3928 surplus in the Accounts. He suspected that there had been trouble with the damned dots and that the excess should be 5·0d., not 0·5d.

Mr. Melling pointed out that the summary referred to subscription income, not total income, and the activities mentioned were those appropriate to membership. He gave some examples of non-subscription income and said that both the ½d. in the summary and the £3928 in the Accounts were correct.

The President, replying to **Mr. F. L. Veale,** confirmed that there was an arrangement between the three engineering institutions for sharing, according to an agreed formula, a part of the costs of the rating litigation, of which the Mechanicals were the spearhead.

The motion for the reception and adoption of the Accounts was then carried without dissent.

Prof. G. W. Carter proposed and **Mr. W. D. Mallinson** seconded that the best thanks of The Institution be accorded to the Honorary Secretaries of all local Centres and Sub-Centres, the Council's Representatives oversea, and the Honorary Secretaries of Oversea Branches and Committees for their valuable services during the past year. This was carried with acclamation.

Mr. Melling proposed a vote of thanks to the retiring Honorary Treasurer, Mr. E. Leete. He had found a tower of strength in Mr. Leete, who, in addition to being Honorary Treasurer for two years this time, had on three previous occasions held the office for the full term of three years. He gave a long list of the services rendered by Mr. Leete since 1925. On all occasions he had shown himself to be a friend not just to The Institution, to the Council, to the President for the time being, but to all members through his great service.

Mr. Goodall, seconding, wished Mr. Leete many more years of happy retirement, and the vote was carried with acclamation.

In a brief reply, **Mr. Leete** paid tribute to the aid and care of the Secretary and the Chief Accountant.

The reappointment of Allen, Attfield and Co. as auditors for 1960–61 concluded the business of the Annual General Meeting, and Dr. A. M. Spooner gave a lecture on 'Technical features of a new television studio at Wembley', which is reported on p. 463.

ANNUAL REPORT FOR 1959-60

Report of the Council presented at the Annual General Meeting of The Institution on the 19th May 1960

Introduction

SECTION A Membership
SECTION B Institution Activities
SECTION C Technical Investigations
SECTION D Joint Activities with Other Bodies
SECTION E Education
SECTION F Institution Library and Publications
SECTION G Finance
SECTION H Institution Staff

Appendixes

APPENDIX A Membership of The Institution
APPENDIX B Growth of Membership over the last 15 years
APPENDIX C Meetings

Introduction

THE Council have pleasure in presenting their Report for the year ended 31st March 1960, at the Eighty-Eighth Annual General Meeting of The Institution.

The rate of increase in The Institution's membership has been well maintained. The total of members of all classes now stands at 46222, of whom 24324 are Corporate members, and the over-all net increase of 1678 has only once been exceeded during the last ten years.

During the year, over 560 candidates were interviewed by representatives of the Council under provisions of the Bye-laws which are intended to afford to a candidate, about whom they may be in doubt, the opportunity of satisfying the Council that he fulfils the necessary requirements for election or transfer.

Recommendations by the Council for amendments to the Bye-laws and for revised rates of membership subscriptions and entrance fees were considered and discussed at three Special General Meetings of Corporate members, in respect of two of which polls were taken on specific resolutions of the Council for increases in fees and subscriptions. In the course of the meetings at which these increases were discussed, many suggestions were put forward on various aspects of Institution life and management, both by members who were opposed to the Council's proposals, and by those who supported them. So that all these points, and others which had been received from members in writing, might be taken into account, a Special Advisory Committee was appointed by the Council to review the suggestions and to make recommendations for improving the channels of communication between the Council and the membership.

The high level of Institution activities has been well maintained. Arrangements are currently in hand for five symposia and conferences, one of particular interest being the Third International Conference on Medical Electronics, to be held from the 21st to 27th July 1960, which the Electronics and Communications Section are organizing on behalf of the Council in association with the International Federation for Medical Electronics.

In September 1959 the then President, Mr. S. E. Goodall, and the Secretary, accompanied by their wives, were present as guests at the Jubilee Celebrations of the South African Institute of Electrical Engineers in Johannesburg, and in the course of their journey attended meetings of members arranged in Uganda, Kenya and Rhodesia, and in Durban and Cape Town.

Close touch has been maintained with sister institutions oversea, in particular through The Institution's continuing support of the Conference of Engineering Institutions of the British Commonwealth, and the Conference of Engineering Institutions of Western Europe and the U.S.A. (EUSEC). A meeting of the latter is to be held in Brussels in the early autumn, at which The Institution will be represented by the President and the Secretary.

In the field of education and training, a noteworthy event has been the introduction of Training Regulations, following the Bye-law revisions which were agreed on the 9th April 1959. These Regulations present an ordered and systematic statement of the requirements for this important phase of an engineer's preparation, and are so written that a candidate may submit his training for assessment at any time after he has qualified for Graduate membership.

During the year, steady progress has been made in the programme of building reconstruction. The first phase, comprising alterations to the third floor with improvements in the Library, has been completed; so has the first stage of the work in the Lecture Theatre, which was brought into use in its present interim condition in time for the Opening Meeting of the session. A new ceiling now being incorporated has been designed to improve the acoustics, and the work of opening up the new side wings and installing the galleries should be completed in time for the Theatre to be used in its final form early in September.

The Council conclude this Introduction by recording their grateful and sincere appreciation of the services which the Honorary Officers at home and oversea perform for The Institution, and express their warmest thanks to them and to many other members who give of their time and experience so ungrudgingly in the interests of The Institution.

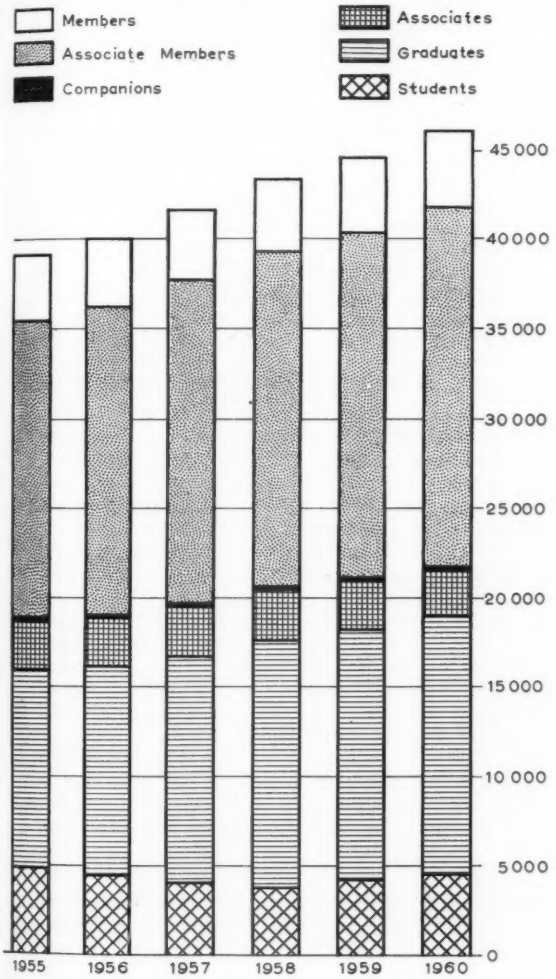
SECTION A

Membership

1 The Register

5589 proposals were considered by the Membership Committee during the year and 2708 new members were elected, compared with 2350 in 1958–59. The resulting net increase of 1678 (all classes) has only once been exceeded during the last ten years.

The total number of Graduates increased by 530 to 14545, notwithstanding that 735 were transferred to the class of Associate Members. There was also a most encouraging increase of more than 34% in the number of Students elected.



1 *Growth in membership*

The total membership of The Institution on the 1st April 1960 was 46222; 24324 being Corporate members, i.e. 53% of the total (Fig. 1). Fewer members transferred from the class of Associate Members to that of Members, and the Council again urge Associate Members qualified to do so to apply for transfer to the senior class. 562 candidates were interviewed by representatives of the Council under the Bye-law provision designed to enable a candidate the better to satisfy the Council that he fulfils the requirements.

Three new admissions bring the number of women Associate Members to 34, the total for all classes of membership being 73.

2 Honorary Members

The Council have elected Col. B. H. Leeson, C.B.E., T.D., PAST-PRESIDENT, to Honorary Membership of The Institution in recognition of his extensive contributions to the application of electrical science and engineering in the manufacture of electrical plant and equipment, to the development of co-operative effort within the electrical industry and to the training of electrical engineers, and of the services he has rendered to The Institution over nearly half a century.

The Council is empowered once in every period of three years to elect an additional Honorary Member who is not at the time of his election a member of any class of The Institution, and they have been pleased to elect Dr. Richard L. Hearn, B.A.SC., LL.D., for his notable contributions in the development of electricity generation and its supply for the benefit and use of mankind, particularly in Canada, and for the part he has played in international co-operation in this field.

3 Faraday Medal

The thirty-eighth award of the Faraday Medal has been made to Sir George Thomson, D.SC., F.R.S., in recognition of his outstanding contribution to the advancement of electrical science, of the leadership in research which he has given to others in this field, and of his inspiring services to education in science and technology.

4 Principal Honours and Distinctions Conferred on Members

Baron

Nelson, Sir George H., BART. (*Member*)

Knight Bachelor

Gamage, L. C., M.C. (*Companion*)

Commander of the Order of the British Empire

Brown, F. H. S., B.SC. (*Member*)
Davies, L. J., M.A., B.SC. (*Member*)
Green, S., B.SC. (*Member*)
Henderson, J., M.C., B.SC. (*Member*)
Nicholas, A. J., O.B.E. (*Member*)
Pattison, Capt. G. R. B., B.SC. (*Associate Member*)
Ramsay, H. T., M.SC.(ENG.) (*Member*)
Sharples, J., B.SC.(ENG.) (*Member*)
Stubbs, Maj. W., M.C. (*Member*)
Turner, Air Comm. C. A., O.B.E., R.N.Z.A.F. (*Associate Member*)
Williams, Frank, B.SC. (*Member*)
Zweigbergk, Brig. C. A., M.C., M.SC.TECH. (*Member*)

Officer of the Order of the British Empire

Barnes, D. E., G.M., B.SC. (*Associate Member*)
Best, Cmdr. K. B., M.V.O., R.N.(RET.) (*Associate Member*)
Brewin, F. J. (*Associate Member*)
Cole, A. W. H. (*Associate Member*)
Douglas, T. K. A., B.SC. (*Member*)
Grant, K. O. (*Member*)
Harman, R. C. (*Associate Member*)
Lawson, C. J. V. (*Member*)
McKinlay, A. (*Associate Member*)
Pout, H. W., B.SC.(ENG.) (*Associate Member*)
Proctor, W. S. (*Member*)

Officer of the Order of the British Empire—*continued*

Skinner, W. R. T., B.SC.(ENG.) (*Member*)
Thorn, W. A. J. (*Associate Member*)
Timberlake, E. J. (*Associate*)
Tyson, W. R., B.SC.(ENG.) (*Member*)
Whittaker, J. E., B.SC.(ENG.) (*Member*)

Member of the Order of the British Empire

Allsop, C. (*Associate Member*)
Atkinson, William, D.C.M., M.M., B.E.M. (*Associate Member*)
Burgess, S. L. (*Member*)
Draper, A., B.SC.(ENG.) (*Member*)
Lewis, C. H. (*Associate Member*)
McKie, A. N. (*Associate Member*)
Marshall, W. J. (*Associate Member*)
Payne, N. G. (*Associate Member*)
Robins, G. W. (*Associate Member*)
Walker, N., B.SC.(ENG.) (*Associate Member*)
Yates, T. A. (*Associate*)

British Empire Medal

Warmoth, D. (*Graduate*)

Emergency Reserve Decoration

Benson, R. H. O. (*Associate Member*)

5 Deaths

The Council record with regret the deaths of the following members of The Institution:

Honorary Member

Angwin, Col. Sir Stanley, K.C.M.G., K.B.E., D.S.O., M.C., T.D., D.SC.(ENG.)

Members

Ainslie, K. O., B.SC.(ENG.)
Alger, T. E.
Anderson, J. A.
Arden, G. D.
Ashley, P. G.
Ayton, R.
Badham, L. H. L.
Bagnall, R. I.
Bell, Lt.-Col. W.
Bird, W., C.B.E., J.P.
Bishop, D. H., B.SC.
Blandford, A. R.
Blue, J. L.
Bradford, G., M.ENG.
Brazel, Lt.-Col. C. H., C.M.G., M.C.
Brent, W. H., B.SC.
Browne, B. F., O.B.E.
Burgess, W. A. A.
Carey-Brown, J., B.SC.
Carr, L. H. A., M.SC.TECH.
Coursey, P. R., B.SC.(ENG.)
Dalton, Sir John C. J.
Dawson, B.
De Guerrier, F. E.
Dixon, W.
Dover, A. T.
Edmondson, F., M.SC.
Edwards, B. J., M.B.E.
Finnimore, T. C., M.B.E.
Franklin, G.
Freeman, J. G.
Gibson, S. C.
Glen-Bott, C. L., O.B.E., M.A.
Goldup, T. E., C.B.E.
Grant, L. S. F.
Gray, A. S.
Grinsted, W. H., O.B.E.
Harber, F. O.
Instrall, Col. R. C., O.B.E., B.A.
Jephcott, E. L. R.
Jones, R. S.
Larke, Sir William J., K.B.E.
Lawson, W.
Leake, F. W.
Leeds, Maj. R. J., T.D.
Lucas, J. G.
Mallinson, A. B.
Marshall, A. H. W.
Marsingall-Thomas, C.
Miller, R. S.
Milliken, Brig. R. C., C.B.E., T.D., D.L.
Munro, J.
Nelson, J.
Newton, F.
Overton, T. R.
Parsons, T. C.
Payn, H.
Peck, H. G. S., B.SC.(ENG.)
Poolcy, L. A. C.
Purrett, J.
Record, J. W.
Richardson, Maj. H., O.B.E., M.C., T.D., J.P.
Richardson, H. W., B.SC.(ENG.)
Robertson, W. J.
Robinson, D. H.
Robson, O. L., M.B.E., B.SC.(ENG.)
Ross, W., M.B.E.
Rowse, A. A., C.B.E., M.A., B.SC.
Sims, J. W.
Smith, H. S.
Smith, J. F., B.SC.(ENG.)
Smith, N. T.
Spicer, F. P.
Stone, H. J., M.C.
Storrar, J. H.
Tattersall, H. W.
Turnbull, W. A.
Unbehaun, A. C.
Ward, H. J.
Watson, Sir Duncan, J.P.
Weymouth, G. A. P.
Whitehouse, M. H.
Wilson, J. L.
Yorke, W.

Associate Members

Allen, F. E.
Baker, G. B., M.A., B.SC.
Barlow, E. B.
Base, G. C.
Batliboi, J. R.
Bell, J. W.
Bennett, C. H. J.
Bergmann, F.
Berry, E.
Berry-Nixon, T. E.
Blackburne-Maze, L. N.
Brassington, H.
Brighten, Maj. H. W.
Bulloch, M. A.
Busemann, F., DR.-ING.
Buxton, W. H.
Cator, F. L., B.SC.
Catterall, G.
Causer, D. S.
Clayton, G.
Clothier, A. J.
Coker, O. O., B.SC.
Connan, Brig. J. C., C.B.E., B.SC.
Cook, E. T.
Cook, G. H.
Cope, H. A.
Coulthard, R. D.
Dallimore, L. M.
De Silva, S. R.
Ditcham, W. T.
Duncan, A. S.
Dyer, A. H.
Dyer, W. S.
Dymond, R. M., B.SC.(ENG.)
Eastwood, J. W.
Ellefsen, O.
Ellmer, J. R.
England, C. J.
Ewens, Air Comm. F. G. H., R.A.F.
Fenn, F.
Fielding, J. G.
Franks, A.
Gatrill, A. F. M.
Gibson, C.
Gooden, C. W.
Goolding, C. L.
Goodman, A. B.
Gover, D. F., B.SC.
Gray, R.
Hardy, W. C. G.
Hewitt, L. B.
Hipwell, Maj. J.
Holburn, R. P., B.SC.
Holland, H. R.
Howarth, V.
Hudson, J. B.
Jackson, W. A.
Jarrett, A. Y.
Jones, R., B.SC.
Jung, T. A.
Khan, K. M. I., B.SC.
Lightfoot, J. J.
Linde, A. J.
Long, Cmdr. R. B. M., R.A.N. (RET.)
McGregor, J. J.
MacKim, A. P.
Maloney, J.
Mason, D. M.
Meredith, F. E.
Morgan, Lt.-Cmdr. A. P.
Mousley, H., M.B.E.
Mugdan, H. J.
Mundie, C. M.
Munro, H.
Naylor, J. R.
Nelson, C. W. G.
Newsome, A.
O'Meara, A., B.SC.(ENG.)
Ostline, J. E.
Panisset, D. S.
Pitts, W. A.
Platt, A. D. B.
Poole, E.
Quenzer, A. E.
Rodger, J. L., B.SC.
Rodwell, H. K.
Rogers, R. A., B.SC.(ENG.)
Rogers, T. H., B.SC.
Rose, A. H. W.
Rose, G. S.
Routledge, L. G. F.
Rowland, T.
Ruebner, A.
Sarjeant, L. K.
Shankariah, N. S., B.SC.
Sharrock, T.
Sheldon, R. A.
Skinner, H. J.
Stansfield, Prof. H., D.SC.
Stevens, S. G., B.SC.(ENG.)
Stokes, H.
Stretch, W.
Sweeney, P. A., B.E., B.SC.
Sykes, A. F., B.SC.(ENG.)
Taylor, E.
Taylor, H. L.
Thompson, C. D., B.SC.(ENG.)
Toma, R.
Toon, A. A.
Toulmin, J.
Trussler, H.
Turpin, A. E.
Underdown, J.
Upstone, W. E.
Velge, G. E.
Vembu, N., M.A.
Vine, B. J.
Vivian, G. H. E.
Watson, P.
Watts, F. G., M.SC.(ENG.), B.SC.(ENG.)
Webster, H. S.
Whitehurst, J. T.
Whitton, G. A., B.SC.TECH.
Wilmot, A. C.
Wotton, W. J., M.B.E.
Younger, T. E.
Younghusband, K.

Companion

Jackson, F. T.

Associates

Alfrey, J. I.
Bennett, Lt.-Col. G.
Buckland, B.
Carrick, C.
Chatwin-D'Horschel, J.
Cree, J. C.
Curr, A. M.
Edwards, J.
Fox, J.
Galloway, J. F., M.B.E.
Gibson, J. B.
Harrison, Wing-Cmdr. A. P., O.B.E.
Hindley, F. T.

Associates—continued

Kinsey, R. W. S.
Murcott, G.
Newth, J.
Parr-Morley, Col. J., M.M.
Parsons, A.
Payne, C. J.
Pemberton, P. E.
Randall, S. G.
Sleath, B.
Sulston, L. E.
Tout, H. E. B.
Tyrrell, F.
Vaughan, J. M.
Welsh, J. H.

Graduates

Andrews, W. M., B.SC.TECH.
Costain, T. P., B.SC.(ENG.)
Lloyd, K. A.
Lovell, P. G., B.SC.
Morley, D. A.
Pryke, N. E.
Sanders, J. S.
Shah, T. Y.

Students

Hide, K. F.
Hinde, J. R.
Meikle, J. H.
Moffatt, G. H.

6 The late Mr. T. E. Goldup

The electrical industry as a whole, and The Institution in particular, sustained a great loss in the sudden death on the 6th October 1959 of Mr. T. E. Goldup, C.B.E., PAST-PRESIDENT. Mr. Goldup had been President of The Institution during the preceding session. His unfailing support of The Institution and the unstinting work which he contributed to the fulfilment of its aims made him a well-loved figure in electrical engineering affairs who will be deeply missed by all who knew him.

7 Members who have Retired, or who are of Long Standing

During the year 241 Members, Associate Members and Associates who have retired from the profession have been relieved under the Council's rules from the payment of further subscriptions, they having reached the age of 60 and having 25 years' continuous membership. Four Companions who had reached the age of 70 were similarly relieved. During the year the Council amended their rules to assist those retired members who have between 15 and 25 years' membership but who cannot obtain income-tax relief on their subscriptions since they are no longer gainfully employed. For 19 members the subscriptions were reduced by two-thirds and for 14 others by one-third. The rules have also been broadened so that the Council may remit in appropriate cases the subscriptions of retired Companions who have more than 10 years' membership.

The subscriptions of a further 85 members were remitted on their completing 50 years' membership of The Institution.

8 The Designation 'Chartered Electrical Engineer'

The fullest use of the title 'Chartered Electrical Engineer' by Corporate members of The Institution is urged and commended by the Council.

9 Unauthorized Use of Membership Initials

The Council take firm action in all cases which come to their notice of the unauthorized use of designations of Institution membership, and as a result, in 1959, satisfactory undertakings and apologies were received from 13 such offenders.

The Council request members to bring the facts of any doubtful cases of which they become aware to the attention of the Secretary.

10 Income Tax—Members' Subscriptions

Under Section 16 of the Finance Act, 1958, The Institution has been registered as an approved body whose members can claim relief from income tax on their membership subscriptions. The Commissioners of Inland Revenue have since agreed to recognize as an allowable expense the cost of Parts of the *Proceedings* purchased annually by members.

11 Revised Rates of Membership Subscriptions and Entrance Fees

At a Special General Meeting of Corporate members held on Thursday, 9th April 1959 to consider changes in the Bye-laws, an amendment that the changes relating to increases in entrance fees and annual subscriptions be deferred for further consideration was adopted by a small majority.

At a Special General Meeting of Corporate members held on Thursday, 25th June 1959, resolutions of the Council that the entrance fees be each increased by one-half of their amount, and that increases specified in a schedule be made in the annual subscriptions, were offered for confirmation, pursuant to Bye-laws 26 and 27. On the first resolution, a poll was demanded and the President directed this to be taken on Thursday, 9th July 1959 at Savoy Place. The three members then withdrew their demand for a poll, and, on a show of hands, the resolution was confirmed by 102 votes to 81. On the second resolution, concerning increases in annual subscriptions, being put, the same three members again demanded a poll, and this the President directed should be taken on the 9th July 1959. The result of the poll was: for confirmation of the Council's resolution, 423 votes (personal 335, by proxy 88); against, 739 votes (personal 349, by proxy 390).

It being necessary in the Council's view, if Institution activities were not to be drastically curtailed and if an adverse balance in the accounts was to be avoided, for increases in annual subscriptions to be approved and to become operative from the 1st January 1960, a further Special General Meeting was held on the 18th August 1959, at which a resolution of the Council for increases in annual subscriptions (some of which were less than those put forward on the 25th June 1959) was offered for confirmation.

On a show of hands, confirmation was given by 369 votes in favour with 139 against. A poll having been demanded by three members, this, on the direction of the President, was taken forthwith, with the following result: for confirmation of the Council's resolution, 4701 votes (personal 302, by proxy 4399); against confirmation of the Council's resolution, 736 (personal 83, by proxy 653).

A brief account of these three Special General Meetings appeared in the November 1959 issue of the *Journal*.

12 Special Advisory Committee

In the course of the Special General Meeting of Corporate members held on the 18th August 1959, the President indicated that he proposed to recommend to the Council the setting up of an *ad hoc* committee to study all the ideas and suggestions received from members both at the three Special General Meetings and in correspondence; to report to the Council the actions they thought desirable; and also to examine means of improving the corporate life of The Institution, and the necessary processes of communication. At their meeting of the 9th October 1959, the Council endorsed this

recommendation and set up a Special Advisory Committee with the following terms of reference and constitution:

(a) To report to the Council on all the comments and proposals received from members, at meetings and in correspondence, on the activities and organization of The Institution and, where appropriate, to recommend suitable action

(b) To make recommendations to the Council on the ways and means of improving the channels of communication between the Council and the members in order to secure a better appreciation of the Council's activities and responsibilities, with a view to improving the corporate life of the body.

Constitution

Members of present Council

Chairman: O. W. Humphreys, C.B.E., B.SC., VICE-PRESIDENT (London)
G. S. C. Lucas, O.B.E., F.C.G.I., VICE-PRESIDENT (Rugby)
J. Collins, MEMBER (Liverpool)
A. T. Crawford, B.SC., MEMBER (Newcastle upon Tyne)
D. C. Flack, B.SC.(ENG.), PH.D., MEMBER (Bristol)
B. L. Metcalf, B.SC.(ENG.), MEMBER (London)
J. R. Rylands, M.SC., J.P., MEMBER (Wakefield)

Past members of Council

A. R. Cooper, M.ENG., MEMBER (London)
E. M. Hickin, ASSOCIATE MEMBER (London)

Members who have not served on the Council

E. J. R. Hardy, B.SC., B.SC.(ENG.), ASSOCIATE MEMBER (Manchester)
W. B. Laing, F.H.-W.C., MEMBER (Edinburgh)
E. L. E. Pawley, O.B.E., M.SC.(ENG.), MEMBER (London)
D. Pitts, ASSOCIATE MEMBER (Bradford)
D. N. Truscott, O.B.E., PH.D., B.SC.(ENG.), SC.D., MEMBER (Coventry)

The Committee have held ten meetings, all but one of which have lasted for the whole day. The range of subjects covered by the comments and proposals, together with those specifically referred to the Committee by the Council, was so broad that their review has had to cover nearly every phase of Institution activities. Considering the wide ramifications and the many differing aspects of The Institution's work, it is understandable that this is proving a formidable task and, although good progress has been made, it has not yet been completed.

The Council are greatly indebted to the Chairman and members of the Committee for the time and care they have devoted to this painstaking review which they feel sure will be of great benefit to The Institution.

13 Reports of Council Meetings in the *Journal*

Starting in January 1960, reports of the proceedings at the meetings of the Council, issued on the authority of the President, have been published in the *Journal*, and their publication will continue as a regular feature, so that members may be kept more continuously informed of the Council's activities.

SECTION B Institution Activities

14 Meetings

During the twelve months ended the 31st March 1960, 1550 meetings of the members, the Council and the various committees were held in London and at the local Centres, an increase of 131 compared with the figure for 1958–59. A detailed statement is given in Appendix C, and Fig. 2 shows the number of meetings held during the past six years.

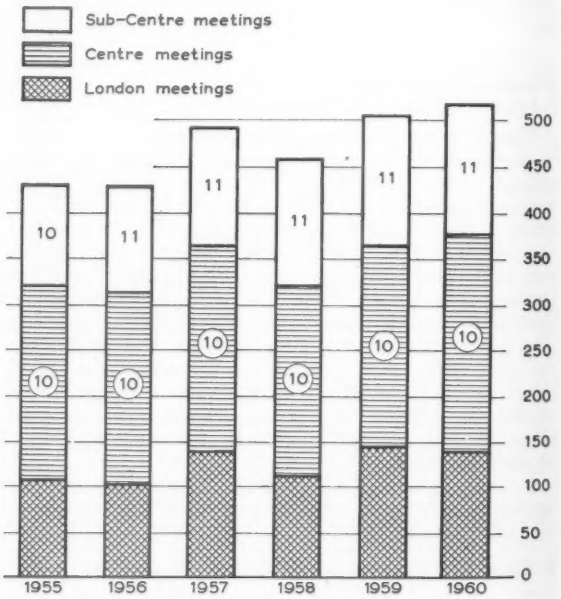
Seventeen Ordinary Meetings were held in London, with an average attendance of 220. The papers read and the ensuing discussions are recorded in the *Proceedings*. In addition the Annual General Meeting and three Special General Meetings (see par. 11) were held.

The Sixth Graham Clark Lecture was this year arranged by The Institution and was delivered on the 3rd March 1960 by Sir Hugh Beaver, K.B.E., LL.D., D.ECON.SC. It was entitled 'Engineering and civilization'.

A public meeting was held at the Central Hall, London, for the delivery of the 1959–60 Faraday Lecture by Prof. M. G. Say, PH.D., M.SC., F.R.S.E., MEMBER (see par. 26).

The Second Hunter Memorial Lecture on 'The protection of electrical systems' was given by Mr. H. G. Bell, M.SC.TECH., MEMBER, in London, and in Manchester, Liverpool, Newcastle upon Tyne and Middlesbrough.

The Fiftieth and Fifty-First Kelvin Lectures were delivered during the period covered by the Report: the Fiftieth on the 23rd April 1959 by Sir David Brunt, SC.D., F.R.S., on 'The Geophysical Year 1957–58', and the Fifty-First on the 31st March 1960 by Prof. C. F. Powell, M.A., PH.D., SC.D., F.R.S., on 'Cosmic radiation'.



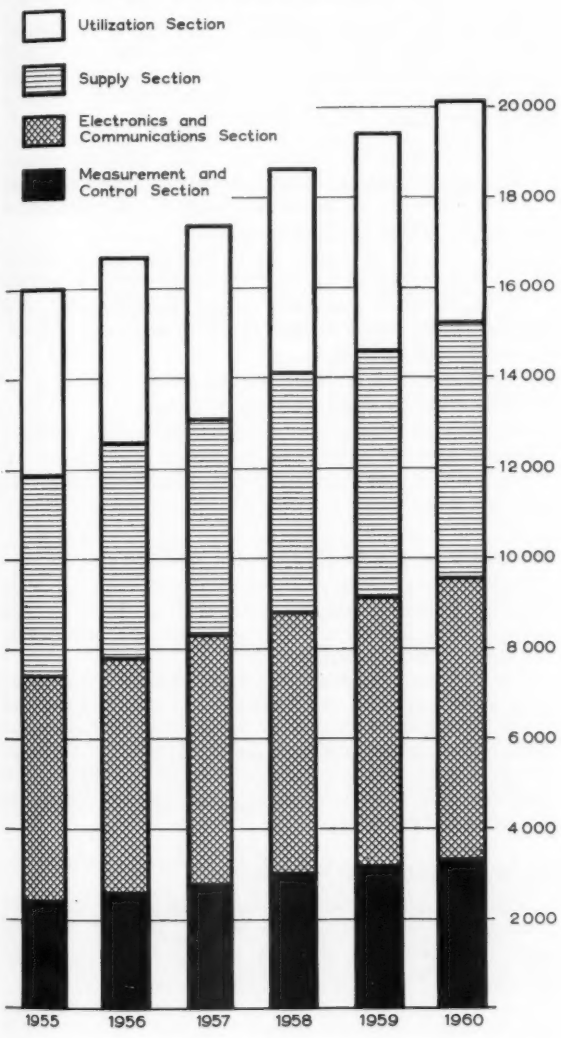
2 *Total number of meetings held in London and in the Centres and Sub-Centres*

15 Specialized Sections

The work of the specialized Sections continues to increase, and there has been a corresponding increase in their membership, as will be seen from Fig. 3. The following statement shows the membership of the Sections, the number of meetings that have been held and the average attendances during the session.

	Membership at 31st March 1960	Number of meetings	Average attendance (figures for last year in brackets)
Electronics and Communications	6171	40	477* (177)
Measurement and Control	3337	15	149 (148)
Supply	5601	10	111 (141)
Utilization	4946	8	86 (126)

* Includes Transistor Convention, Earls Court, attendances



3 *Membership of the specialized Sections*

Electronics and Communications Section

On the 25th June 1959 and the 3rd December 1959 respectively, the Council approved the formation of Joint Electronics and Measurement Groups in the Scottish Centre and the East Midland Centre, and on the latter date approved the reconstitution of the Cambridge Electronics and Communications Group as a Joint Electronics and Measurement Group.

At the end of the 1958–59 Session, two Section meetings devoted to the presentation of formal papers were held and, in addition, two informal evenings. Throughout the current session, the Section Committee have continued the policy reported last year, whereby normal Section meetings are devoted to lectures predominantly of broad general interest, and additional Section meetings are held at which the more specialized papers are read. So far, in addition to the Chairman's Address, seven lecture-type meetings have been held, and five which have been devoted to the reading of papers. The Section Committee continue to believe that this programme structure effectively meets the needs of members of the Section. 182 papers have been submitted to the Committee for consideration; of these 68 related to conventions.

The International Convention on Transistors and Associated Semiconductor Devices, held at Earls Court in May 1959, was attended by more than 2000 participants, of whom 400 came from 26 oversea countries. The associated scientific exhibition was attended by 33 500 persons, including approximately 1000 students.

The Section Committee are at present responsible in whole or in part for the arrangements for the following future conferences and symposia:

(a) *Symposium on Data Handling and Display Systems for Air Traffic Control* to be held on the 8th April 1960

(b) *Symposium on Electronic Equipment Reliability* to be held on the 18th May 1960. This symposium is being organized jointly with the Measurement and Control Section

(c) *Third International Conference on Medical Electronics*, which is being organized in association with the International Federation for Medical Electronics and will be held during the period 21st–27th July 1960. There will be an associated scientific exhibition

(d) *Symposium on Electronic Telephone Exchanges* to be held in the autumn of 1960

(e) *Conference on Components and Materials Used in Electronic Engineering*, which will be held in June 1961 and is being organized jointly with the Measurement and Control Section.

On Saturday, 18th July 1959, a total of 250 members of the Section and their guests visited the Television Centre and Lime Grove Studios of the B.B.C. and the studios of Associated Rediffusion Ltd. at Wembley.

The concluding social event of the year was the Annual Joint Dinner-Dance with the Measurement and Control Section, held at the Café Royal, London, on the 11th March 1960, when about 235 members and their guests were present.

Measurement and Control Section

The Committee have received 81 papers during the year; five were accepted for reading at meetings and 38, of a specialized character, for publication only. A number of papers are still under consideration.

The Annual Lecture was delivered on the 5th May 1959 by Prof. A. L. Hodgkin, M.A., F.R.S., his subject being 'Propagation of electrical signals along nerve fibres'.

The Summer Visit took place on the 27th June 1959, when 77 members and their ladies visited the factories of Standard Telephones and Cables Ltd. and Kolster-Brandes Ltd., at

Footscray. The party were entertained to lunch by Standard Telephones and Cables Ltd. In the afternoon, a tour was made of Knole, followed by tea at Sevenoaks.

The Section Dinner was held at the Café Royal, London, on the 10th November 1959. The principal guest was Dr. G. B. B. M. Sutherland, Director of the National Physical Laboratory, and the company present numbered 270. The Section again joined with the Electronics and Communications Section in a Dinner-Dance (see above).

On the 20th and 21st January 1960, Discussion Meetings on Managerial and Engineering Aspects of Reliability and Maintenance of Digital Computer Systems were held at Savoy Place, in collaboration with the British Computer Society Ltd. and under the aegis of the British Conference on Automation and Computation. These informal discussion meetings, at which contributions were presented at six sessions, aroused great interest, and 615 registrations were received.

Supply Section

Of a total of 42 papers considered during the year, 25 were accepted, 14 of them for reading and discussion at Section meetings. Two Supply Section papers were read at Ordinary Meetings.

The Section Visit was held from the 10th to 13th September 1959 in Dublin. A total of 155 members and their ladies took part.

On the 23rd May 1959 a visit was paid to Aldermaston, when members visited the Associated Electrical Industries laboratory. The attendance of members and their ladies on this visit was 152.

The Annual Dinner-Dance was held on the 30th March 1960 at the Connaught Rooms, London, a record total of 379 members and their ladies being present.

The Section Annual Lecture was delivered on the 20th May 1959 by Mr. P. J. Squire, who took as his subject 'The World Bank—what it is, what it does, and how it works'.

Arrangements are well advanced for a visit to Cardiff to be held from the 29th September to 2nd October 1960, with the kind co-operation of the Western Centre Committee. In addition, a visit to Cambridge will take place on the 21st May 1960.

A Convention on The Impact of Nuclear Development on Electricity Supply and on Instrument Techniques, to be held in September 1961, is being organized by the Section Committee jointly with the Measurement and Control Section Committee, under the aegis of the British Nuclear Energy Conference (see par. 40).

Utilization Section

During the year, 32 papers were considered. Of these, 17 were accepted, 9 being allocated for reading and discussion. One Section paper was read at an Ordinary Meeting.

The subject of the Annual Lecture, delivered by Mr. J. M. Waldram, ASSOCIATE MEMBER, on the 7th May 1959, was 'Lighting and architecture'.

There was a record attendance of 255 members and their ladies at the Annual Dinner-Dance held at the Café Royal, London, on the 15th January 1960.

The Summer Visit, attended by 112 members and their ladies, was held at Bournemouth from the 1st to 3rd May 1959.

Arrangements are in hand for a visit to Oxford to be made from the 13th to 15th May 1960.

On the recommendation of the Section Committee, the Council have set up a Panel on Adequate Wiring for Electrical Installations in Buildings. The terms of reference of the Panel are:

> 'To formulate and publish recommendations of good practice for adequacy of fixed electrical installations in buildings, and to consider the dissemination of such recommendations in order to enable architects, builders, local authorities and others to acquire an informed view of this matter.'

Also on the recommendation of the Section Committee, and acting jointly with the Council of the Royal Aeronautical Society, the Council have set up a Joint Committee on the Applications of Electricity in Aircraft, with the following terms of reference:

(a) To promote the holding of joint meetings to read papers on, and to discuss, matters of common interest to the Royal Aeronautical Society and The Institution of Electrical Engineers

(b) To prepare for submission to the Council of the Royal Aeronautical Society and the Council of The Institution of Electrical Engineers, recommendations for good practice in the design and installation of aircraft electrical equipment.

16 Informal Meetings

The Informal Meetings Committee have arranged seven meetings during the period of the Report. Consideration is being given to the question of how best to arrange their activities in the future.

17 Medical Electronics Discussion Group

The Group's monthly meetings on topics of interest to members of the medical profession and the electrical engineering profession have continued to be well attended by members of both professions.

The Organizing Committee of the Group, by virtue of their membership of the Organizing Committee for the Third International Conference on Medical Electronics, are assisting in making the arrangements for the Conference which is to be held in London in July 1960 under the joint auspices of The Institution and the International Federation for Medical Electronics.

18 Local Centres and Sub-Centres

The ten local Centres, 11 Sub-Centres and 13 specialized Groups held 380 meetings of a general character, compared with 343 during the previous year. 21601 members are attached to the ten Centres as follows:

East Midland	1978	North-Western	3296
Mersey and North Wales	1470	Scottish	2066
North-Eastern	1622	South Midland	3786
Northern Ireland	367	Southern	2090
North Midland	2082	Western	2844

In addition to the General Meetings, a number of social functions have been held, at several of which the President, accompanied by the Secretary, was present. The Vice-Presidents have also visited many of the Centres and Sub-Centres and have deputized for the President at a number of social functions.

The North-Eastern and Scottish Centres celebrated their Diamond Jubilees during the year with ceremonies which

the President attended. To mark the occasions, the two Centres have kindly presented a matched pair of signing desks for use at the new Lecture Theatre at Headquarters.

The successful District Meetings at Bedford have led the Council to authorize the East Midland Centre to form a Bedfordshire Sub-Centre for members in that county and in North Buckinghamshire and North Hertfordshire.

The specialized Groups have catered for the interests of local members of the four specialized Sections. New Joint Electronics and Measurement Groups have been formed in the Scottish and East Midland Centres, and the Cambridge Electronics and Communications Group has been re-formed as a Joint Electronics and Measurement Group.

The Annual Conference of Honorary Secretaries of Local Centres and Sub-Centres enables these officers to discuss many matters of common interest concerning their work for The Institution.

During the year the following Honorary Secretaries of Centres and Sub-Centres have resigned:

Mr. G. B. Devey, ASSOCIATE MEMBER, South-Western Sub-Centre, after seven years of service

Mr. F. F. Freeling, MEMBER, Western Centre, after seven years of service

Dr. W. E. Lewis, B.SC., ASSOCIATE MEMBER, West Wales (Swansea) Sub-Centre, after two years of service

Mr. J. Sykes, ASSOCIATE MEMBER, Sheffield Sub-Centre, after one year of service.

The Council welcome this opportunity of recording their sincere appreciation of the services these members have rendered to The Institution.

19 Local Centre Finances

During the year, it was agreed that the travelling expenses of authors attending the Centres to read their papers should be met from general funds instead of from the local Centre grants; in addition, the main basic grants of the Centres have been increased so that the Centres may increase the scale of their activities.

20 District Meetings

The District Meetings which are held in places throughout the country where Institution membership is too small to justify more formal meetings have continued to be very successful. The work performed by conveners of District Meetings is greatly appreciated by the Council.

21 Graduate and Student Sections

The Committees of the 19 Graduate and Student Sections have continued their efforts to attract more members to their meetings, visits and social functions, and a number are achieving slightly better attendance figures. Two Sections, the East Midland and the Sheffield, held very successful week-end conferences.

Mr. G. O. McLean, M.ENG., ASSOCIATE MEMBER, and Dr. F. A. Benson, M.ENG., ASSOCIATE MEMBER, continued their tour of the Sections with their Students' Lectures entitled, respectively, 'Something for nothing?—Heat-pump achievements' and 'Developments in lighting'. The Council record their appreciation of the service which these two members have performed in this way. They have decided that in future the Lecture should be known as 'The Graduates' and Students' Lecture'.

The Annual Conference of Honorary Secretaries of Graduate and Student Sections was held in November 1959. The suggestions made by that conference are being considered, with other matters, by the Committee on Graduate and Student Section Activities.

22 Oversea Activities

The 11 Oversea Branches and Committees have continued to arrange meetings, visits and social functions appropriate to local conditions. Visits from senior members are always welcome, and those who are going abroad and are prepared to address members or to present an Institution paper are urged to communicate with the Secretary of The Institution.

During the year the Bombay Oversea Committee has been reorganized as an Oversea Branch.

Many oversea members have called at Headquarters during the year, about 190 having signed the oversea register.

In response to an invitation received from the South African Institute of Electrical Engineers, the President of The Institution, Mr. S. E. Goodall, and the Secretary, together with their ladies, travelled to Johannesburg in September 1959 to attend the Jubilee Celebrations of the South African Institute, at which, on behalf of the Council, they presented the Institute with a die and press for their Corporate Seal in honour of the occasion.

En route for South Africa, Mr. Goodall and the Secretary visited Uganda, Kenya and Rhodesia. Meetings of members were arranged, and the party were also entertained by the Councils of the East African Institution of Engineers and The Rhodesian Institution of Engineers. They investigated and discussed problems of technological education in these countries, and also attended meetings of members arranged in Durban and Cape Town.

The nine Joint Groups of the three institutions, including those formed during the year in Gibraltar, Ghana, British Guiana and Aden, have all been very active and have met a real need by providing facilities for meetings for members of the three institutions in places where it might be difficult for the individual institutions to act alone.

The Councils of the three institutions are consulting the Committees of the Joint Groups on proposals which have been put forward to extend membership of the Joint Groups to members of certain other national engineering societies.

During the year the following Oversea Representatives have been appointed by the Council:

Canada
Alberta: Prof. J. A. Harle, M.SC., MEMBER

Near and Middle East
Mr. H. D. Furber, D.F.H., MEMBER (formerly Oversea Representative for the Near East only)
Middle East: Deputy Oversea Representative, Mr. H. W. S. Marshall, MEMBER

New Zealand
Mr. G. R. Milne, B.SC., MEMBER (in place of Mr. E. H. R. Green)

South America
Argentina: Mr. B. G. Borissow, B.SC.(ENG.), MEMBER (in place of Mr. A. C. Towers).

23 Institution Conversazione

Following the Council's decision to hold the Conversazione in alternate years, this function was not held in 1959. The next occasion will be at the Royal Festival Hall, London, on the 23rd June 1960.

24 Annual Dinner

A total of 1487 members and guests were present at the Annual Dinner, held at Grosvenor House, London, on the 25th February 1960.

Sir George Thomson, M.A., LL.D., SC.D., F.R.S. (Nobel Laureate, Faraday Medallist 1960, President of The Institute of Physics, President of The British Association for the Advancement of Science) was the principal guest and proposed the toast of 'The Institution', to which the President replied. The toast of 'Our Guests' was proposed by Mr. S. E. Goodall, M.SC.(ENG.), F.Q.M.C., IMMEDIATE PAST-PRESIDENT, and the response was made by Councillor Group-Capt. G. H. Pirie, C.B.E., J.P. (The Right Worshipful Mayor of the City of Westminster).

A full account of the function will be found in the May 1960 issue of the *Journal*.

25 Summer Meeting

At the invitation of the Chairman and Committee of the North Midland Centre, a Summer Meeting of The Institution was held in the area of the centre from the 15th to 19th June 1959. An account of the meeting, which was attended by 417 members and ladies, was published in the *Journal* for September 1959, and the warm thanks of the Council have been expressed to those who contributed so much to the enjoyment of all present.

For 1960, the Council, on behalf of The Institution, have accepted with pleasure an invitation from the Chairman and Committee of the Scottish Centre to hold a Summer Meeting in Scotland from the 27th June to 1st July 1960.

26 Faraday Lecture

Prof. M. G. Say, PH.D., M.SC., F.R.S.E., MEMBER, Professor of Electrical Engineering, Heriot-Watt College, Edinburgh, kindly accepted the Council's invitation to present the 1959–60 Faraday Lecture on the subject of 'Electrical machines'. He gave the Lecture in Belfast, Birmingham, Cardiff, Dublin, Edinburgh, Glasgow, Hanley, Liverpool, London, Nottingham, Rugby, Sheffield and Southampton. In Birmingham, Liverpool, Nottingham and Southampton, additional Lectures were given before audiences of senior school-children. The Lecture was a great success and fully maintained the high standards set by previous Lecturers.

The Council are most grateful to Prof. Say for undertaking a commitment of such magnitude.

27 Exhibits in the Institution Building

The following exhibits dealing with developments of scientific interest have been shown in the Institution building:

Developments in lighting technique
Transmission of angular-position information by synchro units
Early tori used in nuclear-fusion experiments
Electromagnetic pumps
Aircraft cables
Water-cooled turbogenerator construction
C.T.318 high-voltage (15kV) tester
Model of 120MW turbogenerator.

The Council's thanks have been conveyed to the exhibitors.

The following further exhibit is in preparation:

Properties of steam.

28 Rating Relief

The Council have been pleased to observe that the report of the committee appointed by the Ministry of Housing and Local Government to review the present treatment for rating of hereditaments in England and Wales occupied for purposes of a charitable nature or for other similar purposes (the Pritchard Committee), follows in a number of particulars the proposals which had been put to the committee in a memorandum prepared jointly by the Council and the Councils of The Institutions of Civil and Mechanical Engineers.

The decision given by the Lands Tribunal that The Institution of Mechanical Engineers was entitled to enjoy relief from the payment of rates under the provisions of the Scientific Societies Act, 1843, has been reversed in the Court of Appeal, and leave to carry the appeal to the House of Lords has been granted. In view of the parallel situations of the two institutions, the Council await the outcome with interest.

29 The late Mr. P. S. Hudswell

The Council received, with pleasure, notification that the late Mr. P. S. Hudswell had made a bequest to The Institution, as residuary beneficiary, to found a research benefaction in an amount of the order of £10000.

30 Institution Building

Phase I of the Reconstruction Scheme, involving alterations to the third floor, together with improvements in the Library, has now been completed. The accommodation thus provided consists of a suite of offices for the Editorial Department, and an emergency meeting room and refectory, which latter is now in operation, thus freeing space in the basement, previously occupied for catering purposes, to be handed over to the builders for further reconstruction work.

In accordance with the arrangements reported at the last Annual General Meeting, Phases II and III of the Scheme were merged into one and planned to overlap with the rest of the work in Phase I. Work on these two Phases has been progressing steadily throughout the year, though not without certain setbacks due to unexpected technical difficulties and occasional shortages of labour and materials. However, by the time this Report is presented certain additional office accommodation on the first and second floors will have become available, freeing space hitherto occupied for this purpose on the ground floor which can then be converted into public rooms. It is further anticipated that the additional Meeting Room on the side of the Lecture Theatre will also be available, leaving the second part of the Lecture Theatre work, the first part of which was finished in time for the opening of the present session, to be completed during the summer months by the addition of the side wings and galleries. A further commitment in the Lecture Theatre has arisen owing to an unexpected failure of part of the ceiling. After taking into account the special acoustical requirements of the Theatre, the Building Committee accepted a design of a new ceiling which will in fact be more in keeping with the modern appearance of the new Theatre.

One of the two new lifts embodied in the Scheme was installed and taken over in February 1960. At the same time the existing lift on the Savoy Hill side of the building was taken out of service for a new lift shaft to be completed and a modern automatic lift installed, the work on which is expected to be finished in May 1960. During the next few months, further office accommodation will become available, together with the new Council Room and the suite of three Committee Rooms on the ground floor. There will then follow a concentrated effort to complete the remainder of Phase III, consisting of the reconstruction of the centre bay and the filling in of the front areas to first-floor level for the provision of improved cloakroom and lavatory accommodation for

members, larger reception offices and an extension of the Common Room. It is hoped that all this work will be nearing completion by the end of the year.

The progress of the work has sometimes been impeded by unexpected technical or other difficulties, and inconvenience has inevitably arisen, particularly from noise and dirt; this has been disturbing to committees, to Library users and to staff working near building operations. The Institution's tenants, the British Electrical Development Association, have not of course escaped disturbance in the upheaval, and their tolerance, and indeed full co-operation throughout, are greatly appreciated.

At the last Annual General Meeting it was reported that provision was being made for a total probable cost of £400000, including consultants' and architects' fees. The latest assessment of the over-all financial position, taking into account revised estimates (to completion) for the mechanical and electrical services, the detailed planning of which has necessarily had to follow stage by stage as the architects' working drawings became available, and certain 'extras' which have inevitably arisen, despite stringent economy, in the process of adapting an old building, serves to confirm that the final cost will be close to the estimated figure.

The engrossment of the new lease granted by the Duchy of Lancaster, the negotiations for which were reported at the last Annual General Meeting, was duly received last spring, and the Council gave authority for signing and sealing the lease and the counterpart on the 2nd April 1959.

SECTION C Technical Investigations

31 Codes of Practice

The Council for Codes of Practice (CP/–), which was reorganized in 1954 with the support of the professional Institutions, operates within the framework of the British Standards Institution, with the status of a Divisional Council. Electrical Codes are prepared under the supervision of its Codes of Practice Committee for Electrical Engineering (ELCP/–), the secretariat for which is provided jointly by The Institution and the British Standards Institution. The Institution continues to provide the secretariat for the majority of the Electrical Code Drafting Committees. Codes dealing with radio-interference abatement are referred to in par. 32.

The following revised Code has been issued during the year:

CP 327.201: The reception of sound and television broadcasting.

Account is being taken of comments received following the circulation of the following draft Codes:

CP 321: Electrical installations, to take the place of the existing CP 321: Electrical installations—general, and CP 321.101: Choice, installation and maintenance of electric wiring systems
Earthing (comprehensive recommendations for generating- and sub-stations; overhead lines; low-, medium- and high-voltage systems)
Revision of CP 327.201: Broadcast reception, sound and television by radio
Revision of CP 1003: Flameproof and intrinsically-safe electrical equipment
Maintenance of motor control gear
Measurement and abatement of radio interference in aircraft.

The drafting of the following Codes is proceeding:

Climate-proofing of electrical equipment
Dust-tight enclosures for electrical equipment.

The partial or complete revision of the following Codes is under consideration:

CP 321.102: Installation and maintenance of electrical machines, transformers, rectifiers, capacitors and associated equipment (revision nearing completion)
CP 324.102: Provision of electric lighting in schools
CP 326.101: Protection of structures against lightning
CP 327.300: Sound-distribution systems
CP 327.404/402.501: Electrical fire alarms
CP 1001: Abatement of radio interference caused by motor vehicles and internal-combustion engines
CP 1002: Abatement of radio interference from electro-medical and industrial radio-frequency equipment
CP 1004: Street lighting
CP 1005: The use of electronic valves.

Contact is maintained with Oversea Representatives of the Council and with Secretaries of Oversea Branches and Committees, to whom new Codes and drafts are regularly circulated.

32 Committee on Radio Interference

Exploration of need for interference abatement in the high-frequency broadcasting and television bands (Bands II and III) has been carried further, a number of the bodies represented on the Committee on Radio Interference having collaborated in this work.

The Committee continue to support the activities of a number of sub-committees, convened jointly by The Institution and the British Standards Institution, who are examining various technical issues—one of which deals with relations with the Special International Committee on Radio Interference (C.I.S.P.R.). The Committees dealing with Codes of Practice (see par. 31) maintain liaison with the Committee on matters of policy, and with Technical Committee ELE/32 of the British Standards Institution on matters of standardization.

The advice of the Committee is available to the Postmaster General on any matters within their purview which may arise.

33 Committee on Regulations for the Electrical Equipment of Aircraft

This Committee, and the Committee on Radio Equipment for Civil Aircraft, have completed their consideration of proposals from the Air Registration Board for the amendment of the non-mandatory part of the British Civil Airworthiness Requirements which deals with voltage and frequency tolerances in aircraft electrical supplies, and have submitted their recommendations to the Council.

34 Committee on Radio Equipment for Civil Aircraft

This Committee earlier formulated, at the request of the Air Registration Board, maximum tolerable levels of radio interference from complete electrical installations in aircraft, and recommended that a British Standard Code of Practice be drawn up to give guidance on methods of meeting these levels. A draft of this Code has been circulated for general comment, and the comments are being considered (see par. 31).

The Committee have, in consultation with the Committee on Regulations for the Electrical Equipment of Aircraft, completed their consideration of the question of voltage and frequency tolerances in aircraft electrical supplies (see par. 33).

35 Model Forms of General Conditions of Contract

The following new Model Form has been promulgated on the authority of the Council of The Institution and the Council of The Institution of Mechanical Engineers:

B.2.—Export contracts with delivery f.o.b., c.i.f. or f.o.r., including supervision of erection.

The Joint Committee have begun the revision of Model Form 'A'—Home contracts, with erection, which was last revised in 1948.

36 Wireless Telegraphy Act, 1949

The Postmaster General's Advisory Committee on Wireless Interference from Industrial, Scientific and Medical Equipment submitted a report to the Postmaster General in July 1958 in respect of medical equipment, and during the present year substantial progress has been made towards the formulation of a report regarding industrial radio-frequency equipment; the question of scientific equipment has also been considered. The Institution, jointly with the Post Office, provide the secretariat for this Committee, as for the others which preceded it.

37 Draft Code of Practice on Earthing in Nigeria

During the year The Institution received, for approval or comment, copies of the above draft Code, which had been prepared by the West African Joint Group. The draft Code embodied material based on the corresponding draft British Code so far as this relates to the earthing of consumers' premises, with additions and alterations made necessary by local conditions in Nigeria. The Council have welcomed the proposed Code and have caused to be transmitted to the Joint Group a number of comments on points of technical detail.

SECTION D Joint Activities with Other Bodies

38 Co-operation between Engineering Institutions

To preserve the customary close collaboration of The Institution of Civil Engineers, The Institution of Mechanical Engineers, and The Institution of Electrical Engineers in matters of common interest and concern, the three Presidents have met at frequent intervals for discussions and exchanges of views.

The work of the Joint Advisory Committee on Education (J.A.C.E.) of the three institutions is described in par. 56.

39 Parliamentary and Scientific Committee

In its capacity as an Associated Member, The Institution has continued its support of this Committee, which provides a meeting-place for Members of Parliament and representatives of the pure and applied sciences.

Sir Harold Bishop, C.B.E., B.SC.(ENG.), PAST-PRESIDENT, and the Secretary have continued their services as the Council's representatives.

40 The British Nuclear Energy Conference

Sir Josiah Eccles, C.B.E., D.SC., PAST-PRESIDENT, Sir Willis Jackson, D.SC., F.R.S., PRESIDENT, and the Secretary have continued to serve as The Institution's representatives on the Board of this Conference, which has the task of co-ordinating the activities of its member-societies in the technology of nuclear energy.

41 British Conference on Automation and Computation

Because of the wide range of interest of the member-societies, this Conference is organized in the following three substantially autonomous Groups:

Group A—Engineering applications of automation
Group B—Computation and automatic control
Group C—Sociological and economic aspects of automation techniques.

The Institution continues to provide the secretariat for Group B, of which Mr. J. F. Coales, O.B.E., M.A., F.INST.P., MEMBER, has been elected Chairman, following the death of Mr. T. E. Goldup, C.B.E., PAST-PRESIDENT.

42 Joint British Committee for Vacuum Science and Technology

At the invitation of The Institute of Physics, the Council have agreed to participate in the work of this new Joint British Committee. Prof. M. R. Gavin, M.B.E., M.A., D.SC., MEMBER, and Mr. J. Blears, B.SC.(ENG.), ASSOCIATE MEMBER, serve on the Committee as The Institution's representatives.

43 Great Britain–U.S.S.R. Association

This new Association has been formed for the purpose of arranging contacts and exchanges with the U.S.S.R. on the growing scale now contemplated as a result of discussions held in 1958 with the State Scientific and Technical Committee of the U.S.S.R. Council of Ministers. The Council have decided that they should lend their support to the Association, and Sir Josiah Eccles, C.B.E., D.SC., PAST-PRESIDENT, serves as The Institution's representative on the Association's Council.

The new Association has to a large extent taken over the functions of the Soviet Relations Committee of the British Council, insofar as these were concerned with exchange visits.

44 Joint British Committee for Stress Analysis

This Committee has been set up to act on behalf of a number of bodies of the 'learned society' pattern by maintaining liaison with the Standing Committee for European or International Conferences on Stress Analysis and with other oversea societies and institutes concerned with this subject. The Council have agreed to participate in its activities. The secretariat for the Committee is provided by The Institution of Mechanical Engineers.

45 British Council

Sir Harold Bishop, C.B.E., B.SC.(ENG.), PAST-PRESIDENT, continues to serve as the Council's representative on the British Council's Science Advisory Committee, the Secretary serving similarly on the Science and Engineering Panel.

At the request of the Director-General of the British Council, the views of the engineering institutions were presented by the Secretary at recent intergovernmental discussions between Great Britain and the Soviet Union. This led to the signature of a new Agreement, on Relations in the Scientific, Technological, Educational and Cultural Fields, 1960–61.

Under arrangements made by The Institution at the invitation of the Soviet Relations Committee of the British Council, a team of six British experts in the application of automatic control to industry visited the Soviet Union for a fortnight in May 1959. Copies of their report on this visit may be obtained from the Secretary. Their visit to Russia had been preceded by a corresponding visit of six Soviet experts who visited Great Britain during November and December 1958.

The Council entertained at a tea reception on Friday, 19th February 1960, the members of a British Council Digital-Computer Course.

The Institution has also collaborated with the British Council in a number of other matters of common interest.

46 British Standards Institution

Support of the work of the British Standards Institution has continued.

Details of the Council's nominees on the Engineering Divisional Council and the various Industry Standards Committees and Technical Committees appeared in the January 1960 issue of the *Journal*.

47 Electrical Research Association

Prof. J. Greig, M.SC., PH.D., MEMBER, and Mr. A. W. Montgomery, O.B.E., B.SC.TECH., MEMBER, continue to serve as the nominees of the Council on the Council of the E.R.A.

48 National Inspection Council for Electrical Installation Contracting

The Institution's support for the National Inspection Council has continued. Details of the Council's nominees on the N.I.C. Board were given in the January 1960 *Journal*.

49 British Electrical Power Convention

The Council continue to support the British Electrical Power Convention and are represented on the Council of the Convention by Mr. B. L. Metcalf, B.SC.(ENG.), MEMBER, with the Secretary acting as deputy.

50 Professional Engineers Appointments Bureau

The Council have noted with interest that, on and from the 25th June 1959, the Professional Engineers Appointments Bureau merged with the Engineers' Guild. It is understood that a separate Board, on which electrical engineering is adequately represented, handles the affairs of the former Bureau.

51 Conference of Commonwealth Engineering Institutions

On the invitation of the Engineering Institute of Canada, the next meeting of the Commonwealth Engineering Conference will be held in Canada in September 1962.

52 EUSEC Conference of Representatives from the Engineering Societies of Western Europe and the United States of America

The Royal Belgian Institution of Engineers and Industrialists will act as hosts to the next Meeting of EUSEC, which will be in Brussels from the 29th August to 3rd September 1960.

The membership of the Conference has been increased by the election of The Institution of Civil Engineers of Ireland.

SECTION E Education

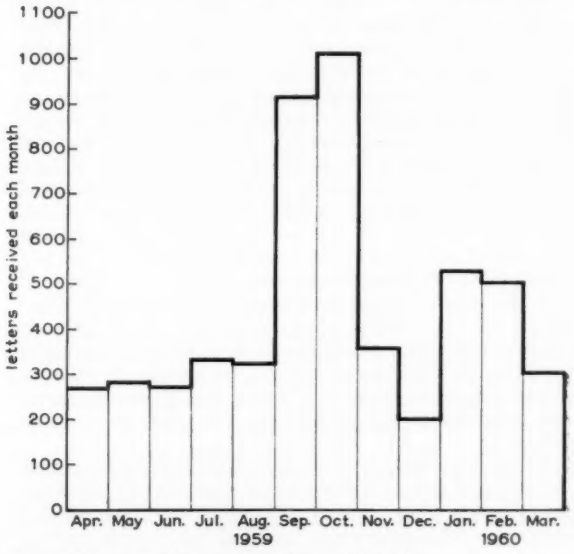
53 Education and Training

Under the revised Bye-laws, applicants for election or transfer to Corporate membership must comply with Training Regulations issued by the Council. The Regulations, published in November 1959, set out the manner in which the training requirements can be met, and bring an ordered arrangement to this important phase of an engineer's preparation for his profession. The Regulations enable a candidate's training to be assessed at any time after he has qualified for Graduate membership, so that he may know to what extent he has proceeded towards satisfying the requirements.

The problem of improving science teaching in schools has received attention, with particular reference to the basic education of those who will ultimately become electrical engineers. A memorandum was sent to the Minister of Education in September 1959, which suggested that the problem of adequate science teaching in grammar schools might be eased if science graduates entering the teaching profession could feel assured of reasonable prospects of attaining an adequately remunerated senior post within that profession. The importance of more generous provision of technician assistance in school laboratories, and of more frequent leave of absence for teachers to attend short courses or summer schools, was also stressed.

Through their representatives on the National Council for Technological Awards, the Council have maintained their interest in the maintenance of adequate standards in colleges where courses leading to the Dip.Tech.(Eng.) in electrical engineering are approved.

The advisory service on education and training continues to answer questions about careers in electrical engineering; Fig. 4 shows that more than 5000 letters asking for advice



4 *Advisory service on education and training*

on education and training were received during the year, nearly 2000 during the peak period in September and October 1959.

54 Education Discussion Circle

There are now Education Discussion Circles in London and in the North Midland, South Midland and North-Western Centres, and the co-ordination of their activities is being studied.

The London Discussion Circle held eight meetings during the year, at which the average attendance was 56, comprising teachers of electrical engineering, industrial training officers and many others interested in educational problems. A number of educationalists from oversea countries have been present at the meetings.

The Fifth Exhibition of Experimental Apparatus for use in colleges was held at The Polytechnic, Regent Street, London, in June 1959.

55 Scholarships

The Council awarded three Research, one Graduate and six Student Scholarships in 1959, their values ranging from £100 to £500 per annum. During the year it was learned that, of past Institution Scholars, three had successfully completed their university research projects; one had been awarded a second-class honours degree and was proceeding to the degree of M.Sc. at the University of Manchester, and another had been awarded a Fellowship of Heriot-Watt College.

Two new awards have been established, the John S. Robinson Memorial Fund, through the generosity of his son, and the Mervyn J. P. O'Gorman Memorial Fund, as the result of a legacy. The Regulations relating to these Funds give wide discretion to the Council, who may in either case make awards of a Student, a Graduate or a Research Scholarship.

56 Joint Advisory Committee on Engineering Education (J.A.C.E.)

The Joint Committee of the three institutions have been concerned with problems common to education and training in civil, mechanical and electrical engineering, and have, for example, advised the three Presidents regarding the educational qualifications to be required for Student membership of the respective institutions after October 1960, when the Common Preliminary Examination will cease to exist as a joint qualifying examination. In general, the standard required will be passes in English language, mathematics, and either two science subjects or one science subject and a foreign language of the General Certificate of Education; or oversea qualifications of equivalent standard.

At the request of the Commonwealth Engineering Conference, J.A.C.E. have acted as a working party to maintain a review of the educational standards of those proposing to enter the engineering profession in countries of the constituent institutions of the Conference, and their conclusions were circulated to each constituent institution in February 1960.

The Joint Committee were asked by the University Grants Committee to give their views on the need for new university institutions in Great Britain and replied that, although the Committee had certain views regarding the possible location of such new institutions, they felt it would be more appropriate to express their opinions regarding the need for the inclusion of engineering faculties in new universities when their locations had been decided. The Committee felt that, even when engineering faculties were included, there was no necessity for the university to be located close to a centre of industry.

57 EUSEC Conference on Engineering Education

The Working Parties established to produce a comprehensive report on the educational systems for prospective professional engineers in the several EUSEC and O.E.E.C. countries have produced two statements of progress during 1959. National Reporters have been appointed for each country, and the majority of their reports have been submitted and sent to the Assessors for examination and revision. It is hoped that a final summary of the reports will be submitted for consideration by the EUSEC Committee on Engineering Education and Training and by the Working Parties in May 1960.

58 Higher Technological Education in India

An appeal launched by the Federation of British Industries, and supported by the Council of The Institution, for funds to provide equipment for the proposed College of Engineering and Technology of New Delhi, has progressed satisfactorily, and the 'Trust Fund' which has been established is likely to be of the order of £300000.

The main difficulty experienced during the past year has been in appointing suitable professorial staff to go to India from the United Kingdom: a problem common to similar projects elsewhere.

59 The Institution Examination

The number of constituent members of the Engineering Institutions Examination Standing Committee for Part I remained at eight during the year 1959, but inquiries have been received from other institutions who are interested in joining. The Institution continues to act as secretariat for the Committee.

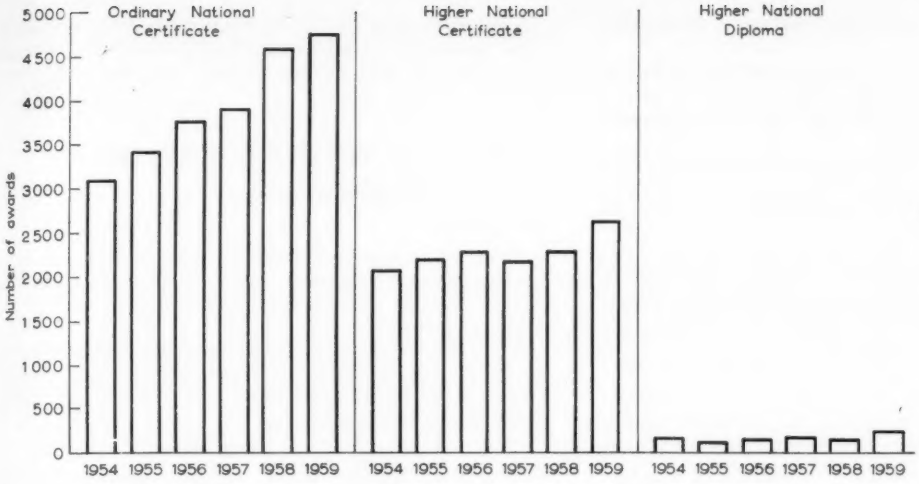
The number of candidates taking the Part II Examination again increased. Most of the candidates were general science degree students taking the two electrical engineering papers only.

A large number of candidates entered for the Part III Examination in June 1959. Entries were received from 35 technical colleges under the arrangements by which block entries from their candidates may be submitted, in order to permit a candidate to take the examination at his college. These entries accounted for approximately 350 candidates, half of whom had qualified for exemption from Parts I and II by Higher National Diplomas, a further third being National Certificate candidates. Candidates may enter for one, two or three subjects at one examination in Part III, and the total number of subject passes during the year was 719 in the United Kingdom and 116 at oversea centres. These results make it evident that the technical colleges which conduct approved preparatory courses for the Examination have acquired greater familiarity with its standard.

The number of candidates examined in 1959 is given below. The Part I Examination figures include only candidates who sought membership of The Institution; the total number entering Part I through all the constituent institutions during the year was 2304.

	1959			
	April–June		*October–December*	
	home	*abroad*	*home*	*abroad*
Part I . .	42	105	61	24
Part II . .	160	55	120	26
Part III . .	403	45	96	27

The English examination for Part I, taken as an individual subject at technical colleges, was entered by 5888 candidates in April and by 812 in October 1959.



5 *National Certificates and Diplomas awarded*

60 National Certificates and Diplomas in Electrical Engineering

Most of the existing Higher National Diploma courses have been revised during the year to conform to the pattern agreed between The Institution and the Ministry of Education and described in a Joint Statement in May 1958. It is hoped that the resulting common standard will lead to the wide acceptance of Higher National Diploma courses as a major qualifying route for professional electrical engineers.

Many colleges have altered their National Certificate courses with two objectives in mind, first to introduce the study of electronics into the earlier years of the courses as befits the importance of this subject to all electrical engineers; and secondly to provide better-planned courses of study for the falling number of National Certificate students who, although qualified to do so, have not been able to transfer to full-time or sandwich courses and who must pursue the alternative part-time route in order to attain Institution membership. In this rearrangement the basic non-electrical subjects of physics and mechanics are taken at a much earlier stage, to provide a firmer base for advanced study. It becomes increasingly evident, however, that the main future purpose of the Higher National Certificate courses will be the provision of a senior technician qualification.

The Ordinary National Certificate is now of great importance as the stage at which selection is made for student apprentices to proceed to courses leading to the Diploma in Technology (Engineering), to the Higher National Diploma or to the Higher National Certificate.

A Working Party, representative of the several National Certificate Committees, the colleges and the Ministry of Education, recommended a speeding up of the procedure of assessment and the issue of pass lists, setting a closing date for the latter operation. With the ready co-operation of assessors and colleges, and the adoption of improved methods within The Institution, electrical engineering was one of the National Certificate schemes which met this target date.

The Council, in association with the Ministry of Education for England and Wales, the Scottish Education Department, and the Ministry of Education for Northern Ireland, awarded National Certificates and Diplomas in electrical engineering to students who successfully completed approved courses at 251 technical colleges in the United Kingdom.

The growth in the number of awards of National Certificates and Diplomas over the past six years is indicated in Fig. 5.

61 Joint Committee on Practical Training

The Joint Committee on Practical Training in the Electrical Engineering Industry have reviewed the implications for industry of the Council's Training Regulations, and after welcoming their introduction set up a Panel to review the report on the Training of Graduates in the light of the new requirements. It is hoped that a revised report will be published later in 1960.

Continued efforts are being made to enlarge the training facilities available in industry, to keep pace with the increasing output from the Universities and Colleges of Advanced Technology. The Joint Committee remain convinced that unused training capacity is to be found in some of the smaller and more specialized firms in the electrical engineering industry, and a Panel is considering ways in which this potential might be realized.

62 Common Preliminary Examination

During the year, six candidates presented themselves for the Common Preliminary Examination at home centres and 76 at centres abroad, the reduction being explained by the fact that the General Certificate of Education is now more firmly established in this country. Facilities abroad for taking alternative examinations have also become more widespread, in particular in Ceylon, where the General Certificate of Education of the Government of Ceylon is now offered by most candidates who proceed to the Institution Examination; and in West Africa, where the West African School Certificate and the Cambridge Oversea School Certificate are becoming more popular. On the other hand, a number of candidates from Israel have recently entered for the Common Preliminary Examination.

63 Examinations

The Examinations Committee, with the help of Committees of the specialized Sections of The Institution, have completed a review of the Part III Examination syllabus, and a revised syllabus was published under the authority of the Council in September 1959 to come into effect in June 1962. This takes account of experience in the conduct of the Examination

since April 1956, and of recent developments in some of the specialized subjects.

A report on course-work submitted for the Part III Examination has been issued to colleges which conduct approved courses; this, it is hoped, will help staff and students to assess the standard of work required.

A revised edition of the Examination Regulations was published in October 1959, and of the Schedule of Accepted Educational Qualifications for Exemption from the Institution Examination in January 1960.

Discussions have taken place with the interested parties on the development of full-time Ordinary National Diploma courses, in the hope of establishing an Ordinary National Diploma in engineering, including both electrical and mechanical subjects as well as the basic sciences.

64 Careers Exhibitions

As in previous years, The Institution has participated in careers exhibitions organized by local education authorities, the youth employment service and Rotary clubs.

The film 'The inquiring mind' was shown at careers exhibitions at Walsall, Harlow, Birmingham, Coventry, Wakefield and Ramsgate, a senior member of The Institution being present on each occasion to introduce the film and to answer questions.

There has been a constant demand for careers literature from schools throughout the country, and any boy who is interested in a career in electrical engineering should be able to find copies of 'The chartered electrical engineer' and 'The education and training of student apprentices in electrical engineering' in his school careers library.

65 Page Prize

The Page Prize was awarded in 1959 to Mr. Colin Thomas Gillies, a student at the Constantine Technical College, Middlesbrough, as having the best performance in the final examinations of the Higher National Certificate in electrical engineering.

66 Henry Nimmo Prize

In 1957 the Henry Nimmo Prize was instituted by the Council to commemorate the life and work of the late Henry Nimmo and his interest in the education and training of those entering the electrical industry. The fund for this award was endowed through a benefaction of Mrs. Nimmo. The Prize will be awarded annually to a student of outstanding merit who obtains an Electrical Technician's Certificate of the City and Guilds of London Institute, and who can satisfy the Council as to the adequacy of the technician training which he has received in the electrical engineering industry.

The first award of this Prize was made during the present session to Beverley William Friend, a student of the South Berkshire College of Further Education, who received his training as a technician at the Aldermaston establishment of the United Kingdom Atomic Energy Authority.

67 Lectures for Young People

The Christmas Holiday Lecture was given in London by Mr. G. G. Gouriet, MEMBER, who took as his subject 'Colour television'. In view of the very large demand for tickets, the Lecture was given three times, once on the 30th December and twice on the 31st December 1959. The total attendance was 1369.

The North-Western Centre arranged a Christmas Lecture on the same topic by Dr. R. Feinberg, ASSOCIATE MEMBER. This was delivered on four occasions (in Bolton, Manchester (twice) and Salford) and was attended by some 1700 young people.

SECTION F Institution Library and Publications

68 Library

Over 570 current periodicals are received by the Library, whose main collection now contains 10000 books, more than 11000 volumes of periodicals, reports, etc., and several thousand pamphlets.

The Table below sets out the additions to the Library during the year, the use made of the Reference Library, and the extent of borrowing from the Lending Library, 1958 figures being shown for comparison.

Reference Library

year	additions to the Library				readers	
	books		pamphlets			
	presented	bought	presented	bought	members	non-members
1958	156	145	1944	298	6579	560
1959	177	164	1368	50	4337	505

Lending Library

year	books added to the Lending Library	books issued	borrowers' tickets issued
1958	145	5052	2391
1959	155	4708	1697

The slight falling-off which is disclosed may perhaps be accounted for by the disturbances arising from the building reconstruction programme.

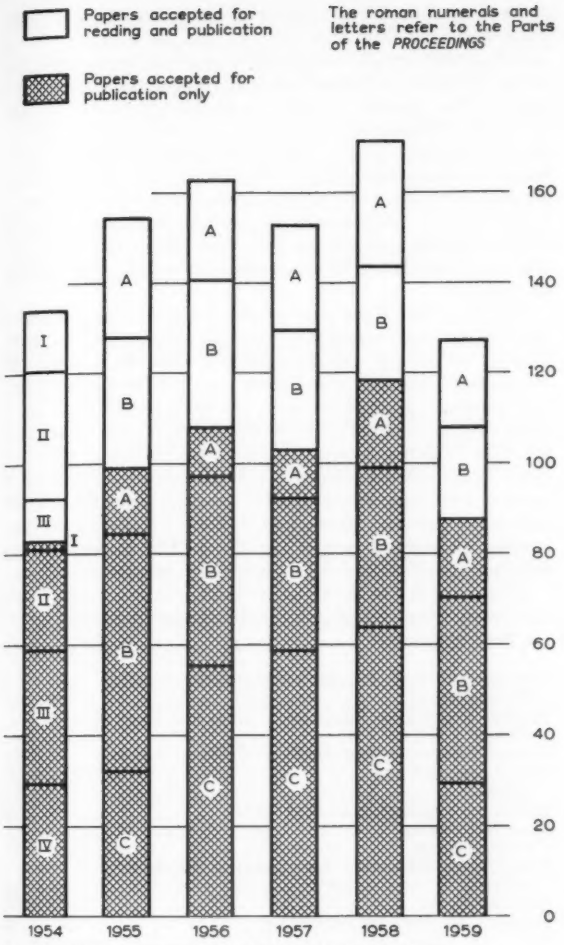
A new edition of the Lending Library Catalogue, price 3s. 6d., was published in September 1959; it lists all books up to the end of July 1959.

69 The *Journal* and *Proceedings* of The Institution

All members receive the *Journal* free of charge. The numbers of non-members who subscribed for it, and of members and non-members who subscribed for the *Proceedings*, in 1959 are given in Table A which also shows the number of pages in the *Journal* and the three parts of the *Proceedings*. Figures for 1958 are included for comparison.

Table A

	no. of pages		no. of members receiving copies		no. of non-member subscribers	
	1958	1959	1958	1959	1958	1959
Journal .	708	757	all members		1942	1880
Proceedings:						
Part A .	658	524	16399	16209	2050	2140
Part B .	630	570	11930	11912	2772	2904
Part C .	558	216	6639	6419	1992	1997
	1846	1310				



6 *Number of papers published in the Proceedings*

Fig. 6 shows in graphical form the number of papers published in the *Proceedings* over the six years 1954–59. Addresses, lectures and progress reviews are excluded from the Figure, as are papers presented at conventions and symposia; the latter were published in Supplements as indicated in Table B.

The smaller size of the normal issues of the *Proceedings* disclosed in Table A and Fig. 6 is due largely to a reduction in the number of monographs, from 64 in 1958 to 30 in 1959; the 1960 figure, however, is likely to be over 50. Fewer papers were read in London, 39 compared with 53, but this was balanced by more lectures and discussion meetings, as reported in Section B. In the summer a dispute in the printing industry lasted for seven weeks, but it had little effect on the size of normal issues of the *Proceedings*, and none on the size of the Supplements, though it led to delays in publication.

The *Journal* in 1959, in spite of the printing dispute, which necessitated a four-page emergency issue in July, increased the number of its text pages by 50 over 1958.

The volume of correspondence published continued to grow. The scope of book reviews was enlarged.

Table B

subject	issue	no. of papers	no. of pages
Electrical equipment of aircraft	1956, **103** A, Suppl. No. 1	20	240
Digital-computer techniques	1956, **103** B, Suppls. Nos. 1–3	55	542
Transatlantic telephone cable	1957, **104** B, Suppl. No. 4	11	126
Ferrites	1957, **104** B, Suppls. Nos. 5–7	47	450
Long-distance propagation above 30 Mc/s	1958, **105** B, Suppl. No. 8	23	191
Radio aids to aeronautical and marine navigation	1958, **105** B, Suppl. No. 9	18	208
Microwave valves	1958, **105** B, Suppls. Nos. 10–12	87	648
Position control of massive objects	1958, **105** C, Suppl. No. 1	2	62
Thermonuclear processes	1959, **106** A, Suppl. No. 2	20	188
Long-distance transmission by waveguide	1959, **106** B, Suppl. No. 13	29	199
Stereophonic sound recording, reproduction and broadcasting	1959, **106** B, Suppl. No. 14	4	63
Transistors and associated semiconductor devices	1959, **106** B, Suppls. Nos. 15–18*	145	1144

* Published in January, February, March and April 1960

As noted in par. 13, brief accounts of Council meetings have, by the direction of the Council, been included in the *Journal* from the January 1960 issue onwards.

70 *Students' Quarterly Journal*

Over 9500 copies of each issue of the *Students' Quarterly Journal* are circulated, containing technical papers, book reviews, and correspondence from members of Graduate and Student Sections, as well as reports of the activities of these. The Editor of the *Students' Quarterly Journal* attends a number of Section Meetings each year, when he describes and explains his aims and encourages the submission of correspondence and short contributions of a general nature.

71 Premiums

The Premiums awarded by the Council for papers read at meetings or accepted for publication only will be announced in the *Journal* during the summer of 1960.

72 *Science Abstracts*

A Section Editor for Section A (Physics) was appointed in January 1960, and with an enlarged staff of Assistant Editors the number of abstracts published was substantially increased; the total number was 14 016 compared with 9201 in 1958. The number of abstracts published in Section B (Electrical Engineering) was also increased, the total being 7718 compared with 6434 in 1958.

73 Regulations for the Electrical Equipment of Buildings

Over 110 000 copies of the 13th edition of the Regulations, which was promulgated on the 1st September 1955, and to which amendments having effect from the 15th December 1958 were approved by the Council, have been sold.

A second edition of the Recommended Practice for Electrical Installations in Caravans, based on the Regulations

and first issued in 1954, was issued in 1956 and has received wide support; over 3000 copies have been sold.

Copies of the 1958 amendments to the Wiring Regulations are obtainable separately from The Institution, price 1s. 6d., and nearly 15000 have been sold.

During the year, eight sets of abstracts of those interpretations of the Regulations which raise clear-cut issues and are of general interest have been issued and published in the *Journal*, reprints being available from the Secretary.

Liaison is maintained with the British Standards Institution regarding British Standards cited in the Regulations, and a number of important draft Standards have been scrutinized from the aspects of safety from fire and shock. A number of matters which may need to be dealt with in a further edition of the Regulations are being considered by the Wiring Regulations Committee and their sub-committees.

74 Regulations for the Electrical Equipment of Ships

On behalf of the United Kingdom National Committee of the I.E.C., the Committee on Regulations for the Electrical Equipment of Ships acts as United Kingdom Committee for liaison with I.E.C. Technical Committee No. 18. The first edition of an I.E.C. Code of Recommended Practice for Electrical Installations in Ships was published in 1957. Outstanding matters to be dealt with in a proposed second edition of the recommendations were considered at meetings held in Italy in May 1957, at Konstanz, Germany, in June 1958 and at Madrid in June 1959. A number of items which were then deferred will be considered at a further meeting of the I.E.C. Technical Committee No. 18 to be held at Tours, France, in May 1960.

In 1956 the Council authorized the preparation of a fourth edition of the Regulations for the Electrical Equipment of Ships, to take the place of the third edition (1939) with 1947 supplement. Sub-committees have completed the necessary technical investigations, and a complete draft of the fourth edition is nearing completion, for submission to the parent Committee.

SECTION G Finance

75 Accounts for 1959

In his report to the members at the Annual General Meeting held on the 14th May 1958, the Honorary Treasurer stated that the Accounts for 1959 would be designed to show the true cost of the many activities of The Institution by allocating salaries and accommodation charges to departments. This has been done in the 1959 Accounts attached to this Report, but it has not been possible to analyse the figures shown for 1958 in the same way.

In making comparisons between the costs for 1958 and 1959 it should be noted that the Management total for 1959 includes some £2000 for additional staff engaged mainly on Convention work. This is, of course, part of the total salary cost of £4666 shown under the heading of Conventions at the foot of p. 423.

The Institution building costs have increased, largely because of the transfer of £4000 to the Repairs Suspense Account. No transfer was made in 1958, but this allocation was provided for in the budget for 1959 because during the rebuilding no work except the minimum necessary for maintenance has been carried out and it is now time to commence some of the deferred major overhaul and decoration of other parts of the building.

The appearance of a considerable increase in the total cost of the *Journal* and *Proceedings* is due to the allocation to this item of the appropriate salaries and accommodation. The actual publishing costs in fact fell to £15443 against £21589; the cost of production fell by about £3200, while the receipts improved by nearly £3000. The lower cost of production resulted from the printing strike which made publication of a normal July 1959 issue of the *Journal* impossible. Printing costs advanced generally by 7½% from September 1959, and, while this had little effect on expenditure in 1959, it will be felt in 1960.

Comparisons of the two years' figures for the remaining items in the Accounts show clearly the effect of allocating the charges for salaries and departmental rents, and do not call for special comment apart from the item of Conventions. Conventions appeared twice in the 1958 Accounts, two of them costing £2485 and the third showing a credit balance of £364. In 1959 five conventions were held, and the efforts to make them self-supporting were successful. An excess of income over expenditure of £317 resulted after charging the staff costs involved, amounting to £4666. Conventions have become an integral part of the life of The Institution, and whenever possible they will be made self-supporting.

Before turning to the Balance Sheet, it is interesting to see how each £1 of membership subscription received in 1959 has been expended:

Management: Staff, Printing and Stationery, Postage, Telephones, etc.	6s. 9d.
Institution Building: Furniture, Fittings and Depreciation	1s. 2d.
Journal, *Proceedings* and *Students' Quarterly Journal*	3s. 10½d.
List of Members	4d.
Libraries	9½d.
Institution Meetings and Local Centres	3s. 10½d.
Oversea Branches	5d.
Faraday Lecture	4½d.
Membership, Education Activities and Scholarship Awards	1s. 3½d.
All other items	1s. 1½d.
Excess of Income over Expenditure	½d.
	£1 0s. 0d.

The first item on the Balance Sheet, 'creditors', has increased by some £20600 in 1959. This is accounted for mainly by bills received for the building reconstruction work in December 1959, which were, of course, paid in January 1960.

The Building Reserve Fund shows the amounts allocated to it during the year, the loss on the sale of Securities and a transfer of the expenditure on account of the work during the year. The donation entered as £5 (actually £5 5s.) was sent by a retired member, who, being exempted from the payment of further membership subscriptions, wished to make his contribution.

The amount spent on the rebuilding work, namely £160694, is automatically transferred to the Surplus of Assets over Liabilities, and the value, or cost, of the Institution building is increased correspondingly.

A small bank overdraft was required at the end of 1959, but this cost only £58 in interest charges. This enabled us to hold for a further two months a short-term security of £90000 earning 4¼% per annum, representing a gain of £637 gross, or £579 net. This short-term security has now matured, and the money has been used towards the cost of the rebuilding work. It will be necessary later in 1960 to use the

overdraft facilities placed at The Institution's disposal by the bank, and there may be a substantial overdraft at the year's end, depending on the rate of progress made by the builders.

The item of Furniture, Fittings and Equipment shows heavy additions during the year, largely accounted for by the cost of the new seating and furniture in the Lecture Theatre.

The over-all result of the year's working is that there is a small improvement on the estimates approved by the Council in December 1958. This results from the decrease in printing costs owing to the strike, the success of the financial arrangements of the Conventions, and the reconstruction of the building being behind schedule.

SECTION H Institution Staff

76 The Staff

The Council wish to express their warm appreciation for the manner in which the Secretary and his staff have continued to carry out their duties in maintaining the manifold activities of The Institution.

APPENDIX A Membership of The Institution

The changes in membership since the 1st April 1959 are shown in the following Table:

	Hon. Mem.	Mem.	Assoc. Mem.	Com.	Assoc.	Grad.	Stud.	Totals
Totals at 1st April 1959	18	4167	19523	75	2649	14015	4097	44544
Additions during the year:								
Elected ..	2	—	190	4	51	747	1714	2708
Reinstated	—	1	14	—	1	6	15	37
Transferred to	—	177	754	—	—	736	—	1667
Totals	2	178	958	4	52	1489	1729	4412
Deductions during the year:								
Deceased	1	85	127	1	27	8	4	253
Resigned	—	10	54	3	51	77	79	274
Lapsed ..	—	3	58	—	31	139	309	540
Transferred from	—	—	177	—	10	735	745	1667
Totals	1	98	416	4	119	959	1137	2734
Net change	+1	+80	+542	—	−67	+530	+592	+1678
Totals at 1st April 1960	19	4247	20065	75	2582	14545	4689	46222

APPENDIX B Growth of Membership over the last fifteen years

year (31st March)	Corporate members	non-Corporate members	total membership	annual increase
1946	13447	15711	29158	2493
1947	14501	16759	31260	2102
1948	15206	17701	32907	1647
1949	16027	18344	34371	1464
1950	16648	18900	35548	1177
1951	17146	19412	36558	1010
1952	17757	19496	37253	695
1953	18510	19272	37782	529
1954	19552	18944	38496	714
1955	20355	18943	39298	802
1956	21089	18949	40038	740
1957	22097	19425	41522	1484
1958	22879	20349	43228	1706
1959	23708	20836	44544	1316
1960	24324	21898	46222	1678

APPENDIX C Meetings

Meetings held during 12 months ended the 31st March 1960:

General Meetings		
Ordinary Meetings	17	
Annual General Meeting	1	
Annual General Meeting (Benevolent Fund)	1	
Special General Meetings	3	
E. and C. Section	40	
M. and C. Section	18	
Supply Section	10	
Utilization Section	8	
Informal Meetings	7	
Education Discussion Circle	8	
Medical Electronics Discussion Group	7	
Special Lecture	1	
District Meetings	16	
*Local Centres		
East Midland	16	(5)
Cambridge E. and M. Group	8	(4)
Mersey and N. Wales	24	(10)
North-Eastern	19	(12)
M. and E. Group	12	(6)
North Midland	22	(10)
Utilization Group	5	(5)
North-Western	11	(13)
E. and C. Group	5	(6)
M. and C. Group	5	(5)
Supply Group	5	(6)
Utilization Group	5	(6)
Northern Ireland	9	(8)
Scottish	—	(6)
E. and M. Group	6	(4)
South Midland	17	(7)
E. and M. Group	6	(6)
S. and U. Group	5	(6)
Southern	31	(8)
Western	13	(9)
Supply Group	7	(5)
Utilization Group	7	(2)
*Local Sub-Centres		
East Anglian	18	(6)
North Lancashire	11	(9)
North Scotland	19	(9)
North Staffordshire	10	(8)
Rugby	10	(6)
Sheffield	16	(8)
South-East Scotland	19	(7)
South-West Scotland	16	(7)
South-Western	9	(8)
Tees-Side	7	(9)
West Wales (Swansea)	7	(7)
*Graduate and Student Sections		
Bristol	11	(5)
Cardiff	8	(10)
East Midland	12	(8)
London	23	(11)
Mersey and N. Wales	17	(8)
North-Eastern	21	(6)
North Midland	10	(7)
North Scotland	6	(3)
North Staffordshire	12	(8)
North-Western	11	(11)
Northern Ireland	7	(5)
Rugby	12	(6)
Sheffield	10	(9)
Southern	10	(4)
South-East Scotland	10	(6)
South Midland	12	(7)
South-West Scotland	7	(7)
Tees-Side	6	(7)
	722	(361)

Council and Committee Meetings	
Council Meetings	13
London Committees:	
Education and Training (and Panels)	18
Electronics and Communications Section (and Sub-Committees and Panels)	120
Engineering Institutions Examination Part I	5
Examinations (and Sub-Committees)	21
Finance (and Sub-Committees)	12
General Purposes (and Sub-Committees and Panels)	27
Hon. Secretaries' Conference:	
Local Centres and Sub-Centres	1
Graduate and Student Sections	1
Incorporated Benevolent Fund (and Sub-Committees)	12
Informal Meetings	5
Joint Committee on Model Forms of General Conditions of Contract (and Sub-Committees)	1
Joint Committee on Practical Training (and Panels)	11
Joint Oversea Activities	1
Library and Museum	1
Local Centres	3
Measurement and Control Section (and Sub-Committees and Panels)	34
Membership (and Sub-Committees and Panels)	46
National Certificates:	
England and Wales (and Sub-Committees)	12
Northern Ireland	1
Scotland	1
Oversea Activities	2
Papers (and Sub-Committees)	16
Regulations for the Electrical Equipment of Ships (and Sub-Committees)	9
Scholarships (and Panels)	3
Science Abstracts	4
Special Advisory Committee	9
Supply Section (and Sub-Committees)	14
U.K. Advisory on Ships (and Sub-Committees)	3
Utilization Section (and Sub-Committees)	18
Wiring Regulations (and Sub-Committees)	4
Other London Committees	9
Centre, Sub-Centre and Graduate and Student Section Committees (see details in parentheses in left-hand column)	361
	798

Also Code Drafting Committees convened for the Council for Codes of Practice	30
General Meetings	722
Council and Committees	798
Codes of Practice	30
Grand Total	1550

* The number of Committee meetings held is shown in each case in parentheses, and the total number of these Committee meetings is entered at the foot of the right-hand column

ACCOUNTS FOR 1959

Income and Expenditure Account for the Year ended 31st December 1959

EXPENDITURE

Year ended 31 Dec. 1958 Dr. £	Cr £		£	£	£
		MANAGEMENT:			
		Salaries, Wages and National Insurance	101,224		
		Staff Provident Scheme	7,565		
		Staff Canteen Subsidies	929		
		Printing, Stationery and Office Requisites	11,626		
		Postage of Correspondence and Notices	4,486		
		Telephone	1,745		
		Travelling Expenses	4,383		
				131,958	
		Less Charged to 'SCIENCE ABSTRACTS'		4,250	
118,855				127,708	
		Less Salaries Charged to Departments		63,509	
					64,199
		INSTITUTION BUILDING:			
		Ground Rent		3,550	
		Rates		6,036	
		Heating		2,695	
		Lighting and Power		1,160	
		Insurance		593	
		Household Requisites and Cleaning		4,461	
		Transfer to Repairs Suspense Account		4,000	
				22,495	
		Less Rents from Tenants	3,545		
		Charged to 'SCIENCE ABSTRACTS'	1,430		
				4,975	
9,279				17,520	
		Add Charge for Salaries		2,877	
				20,397	
		Less Accommodation Charged to Departments		14,550	
					5,847
2,079		FURNITURE AND FITTINGS (Repairs and Renewals)			3,762
		JOURNAL AND PROCEEDINGS:			
		Printing		39,755	
		Paper		28,510	
		Postage		22,223	
		Wrappers and Envelopes		1,800	
				92,288	
		Less Subscriptions	21,364		
		Sales and Advertisements	55,481		
				76,845	
21,589				15,443	
		Add Charge for Salaries		17,590	
		Charge for Accommodation		1,050	
					34,083
		LIST OF MEMBERS—PART 1:			
1,198		Printing, Paper and Postage, *less* Receipts		2,498	
		Add Charge for Salaries		383	
		Charge for Accommodation		200	
					3,081
2,707		STUDENTS' QUARTERLY JOURNAL (Editing, Printing, Postage, etc., *less* Sales)			2,459
		LIBRARIES:			
		Lending Library (Books, Printing, Postage, etc.)		325	
		Reference Library Depreciation		874	
1,381				1,199	
		Add Charge for Salaries		4,920	
		Charge for Accommodation		1,750	
					7,869
		'SCIENCE ABSTRACTS':			
		Block Contribution		3,016	
		Per Capita		1,717	
4,609				4,733	
	1,937	*Less* Members' Subscriptions		1,772	
					2,961
		INSTITUTION MEETINGS:			
4,089		Advance Proofs, Reporting, Refreshments, etc.		4,258	
		Add Charge for Salaries		2,889	
		Charge for Accommodation		10,000	
					17,147
		CONVENTIONS:			
		Symposium on Long-Distance Propagation		—	
		International Convention on Microwave Valves		—	
2,485					—
		LOCAL CENTRES:			
		Administration and Meetings Expenses		16,909	
		Travelling Expenses		323	
		Students' Lectures		456	
16,087				17,688	
		Add Charge for Salaries		1,988	
					19,676
184,358	1,937	CARRIED FORWARD			161,084

EXPENDITURE—continued

£	£		£	£
184,358	*1,937*	BROUGHT FORWARD		161,084
		OVERSEA BRANCHES:		
		Administration Expenses	3,006	
		Loss on Exchange on Remittances to London	668	
3,381			3,674	
		Add Charge for Salaries	310	
				3,984
1,989		Faraday and Children's Lectures	3,398	
		Add Charge for Salaries	44	
				3,442
		MEMBERSHIP DEPARTMENT COSTS:		
		Charge for Salaries	9,850	
		Charge for Accommodation	300	
			10,150	
	5,939	*Less* Entrance and Transfer Fees	4,765	
				5,385
		EDUCATION, EXAMINATIONS AND NATIONAL CERTIFICATES:		
		Charge for Salaries	12,940	
		Charge for Accommodation	1,050	
			13,990	
16,577		Examiners' Fees, Postage, etc.	18,636	
			32,626	
	26,065	*Less* Candidates' Fees etc.	27,713	
				4,913
		TECHNICAL DEPARTMENT:		
		Charge for Salaries	4,960	
		Charge for Accommodation	200	
			5,160	
	4,325	*Less* Sales of Publications	4,947	
				213
357		PREMIUMS FOR PAPERS ETC.		469
1,890		SCHOLARSHIPS provided from Institution Funds		1,630
		GRANTS:		
		Electrical Research Association	500	
		British Standards Institution	250	
		C.I.G.R.E.	76	
		Others	158	
962				984
		CONFERENCES:		
		British Electrical Power Convention	—	
		Commonwealth Engineering Conference	300	
		Conference of Engineering Societies of Western Europe and U.S.A.	100	
2,543				400
667		PUBLIC RELATIONS ADVISER		—
340		ANNUAL DINNER, Cost *less* Receipts	389	
		Add Charge for Salaries	92	
				481
551		Audit Fee		577
406		Legal Expenses		552
548		Conversazione		—
174		Speaking Portraits		350
3,495		Miscellaneous Expenses		3,250
—		Bank Interest Charges		58
8,549		TRANSFER TO REBUILDING RESERVE FUND		7,062
278		TRANSFER TO SINKING FUND (PREMIUMS for Redemption of Cost of Building and Lease)		278
		DEPRECIATION:		
1,244		Furniture, Fittings and Equipment		1,345
228,309	*38,266*			
38,266				
190,043	—			196,457
5,057		EXCESS OF INCOME OVER EXPENDITURE TRANSFERRED TO BALANCE SHEET		3,928
£195,100				£200,385

NOTE—Transfers between expense headings in respect of Salaries and Accommodation have been estimated

INCOME

Year ended 31 Dec. 1958		£	£
£			
184,063	SUBSCRIPTIONS		189,830
430	LIFE COMPOSITIONS		167
8,549	INTEREST ON INVESTMENTS		7,062
617	DEPOSIT INTEREST		440
1,077	SALES OF CONVENTION PROCEEDINGS		2,569
	CONVENTIONS:		
	Digital-Computer Techniques		
	Long-Distance Transmission by Waveguide		
	Stereophonic Sound Recording etc.		
	International Convention on Transistors etc.		
	Convention on Thermonuclear Processes		
	Entrance Fees, Papers, Processing, etc.	25,811	
	Less Expenditure	20,828	
364		4,983	
	Less Charge for Salaries	4,666	
			317
£195,100			£200,385

Balance Sheet, 31st December 1959

1958 £		£	£
80,051	CREDITORS		100,656
18,362	SUBSCRIPTIONS ETC. RECEIVED IN ADVANCE		23,552
	REBUILDING RESERVE FUND:		
	Balance at 1st January 1959	224,789	
	Add Transfer from Income and Expenditure Account	7,062	
	Donation	5	
		231,856	
	Less Loss on Sale of Securities	29,115	
	Transfer to Surplus Account	160,694	
		189,809	
224,789			42,047
2,000	LEGACY FROM ESTATE OF THE LATE LT.-COL. J. P. O'GORMAN		—
903	RESERVE FOR CONTINGENCIES		903
—	RESERVE FOR FUTURE CONFERENCES		400
27,495	RESERVE FUND FOR DEPRECIATION OF INSTITUTION BUILDING AND LEASE, BEING SURRENDER VALUE OF SINKING FUND POLICIES		28,570
	REPAIRS SUSPENSE ACCOUNT:		
	Balance at 1st January 1959	1,310	
	Transfer from Income and Expenditure Account	4,000	
		5,310	
	Less Expenditure on Repairs in 1959	977	
1,310			4,333
	Surplus of Assets over Liabilities:—Balance at 1st January 1959	87,010	
	Add Balance of excess of Income over Expenditure transferred	3,928	
	Transfer from Rebuilding Reserve Fund	160,694	
87,010			251,632
—	Bank Overdraft		11,451
£441,920			£463,544

1958 £		£	£
79,499	INSTITUTION BUILDINGS AND LEASE (at cost)	79,499	
	Add Part cost of reconstruction	160,694	
			240,193
27,495	SINKING FUND (Surrender Values of Policies for Redemption of Cost of Building and Lease)		28,570
	LIBRARY (exclusive of the Ronalds Library and Faraday Papers, which are held in trust, but inclusive of the Thompson Library):		
	As per last Balance Sheet	7,966	
	Additions in 1959	1,770	
		9,736	
	Less Depreciation at 10% (excluding the Thompson Library)	874	
7,966			8,862
	FURNITURE, FITTINGS AND EQUIPMENT:		
	As per last Balance Sheet	19,591	
	Additions in 1959	11,165	
		30,756	
	Less Depreciation	1,345	
19,591			29,411
21,076	DEBTORS		26,353
4,746	INSURANCE PREMIUMS AND SUNDRY PAYMENTS IN ADVANCE		4,644
12,028	STOCKS OF STATIONERY AND PAPER		16,456
224,789	REBUILDING FUND. INVESTMENTS (at cost):		
	Loan to Local Authority		42,047
	GENERAL FUND INVESTMENTS. INVESTMENTS (at cost):		
14,585	British Government Securities	14,585	
	(*Market value 31st December 1959*, £12,245: 1958, £13,776)		
—	Loan to Local Authority	47,953	
			62,538
1,418	CASH IN HANDS OF LOCAL CENTRES ON 31ST DECEMBER 1959		1,647
2,322	CASH IN HANDS OF OVERSEA BRANCHES ON 31ST DECEMBER 1959		2,188
330	CASH IN HANDS OF SECRETARY		635
26,075	CASH AT BANK		—
£441,920	ERNEST LEETE, *Honorary Treasurer* — W. K. BRASHER, *Secretary*		£463,544

Report of the Auditors to the Members of The Institution of Electrical Engineers

We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purposes of our audit. In our opinion proper books of account have been kept by The Institution so far as appears from our examination of those books. We have examined the above Balance Sheet and annexed Income and Expenditure account which are in agreement with the books of account. In our opinion and to the best of our information and according to the explanations given us the said accounts are properly drawn up and the Balance Sheet gives a true and fair view of the state of The Institution's affairs as at 31st December 1959. We have not been able to verify the accuracy of the transfers mentioned in the note on the previous page. Subject to this the Income and Expenditure account gives a true and fair view of the excess of Income over Expenditure for the year ended on that date.

9th March 1960

ALLEN, ATTFIELD AND CO., *Chartered Accountants*

BLUMLEIN-BROWNE-WILLANS PREMIUM FUND

	£ s. d.		£ s. d.
Capital Account	700 0 0	Investment (at cost): £686 10s. 0d. British Electricity 4¼% Stock (1974–79)	700 0 0
	£700 0 0		£700 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Balance carried to Balance Sheet	135 1 0	By Balance (as per last Account)	105 17 6
		„ Interest received	29 3 6
	£135 1 0		£135 1 0

WILLIAM BEEDIE ESSON SCHOLARSHIP TRUST FUND

	£ s. d.		£ s. d.
Capital Account	2,808 12 6	Investments (at cost):	
		£1,755 15s. 6d. 3½% War Stock	1,853 2 6
		£200 New Zealand 3¼% Stock (1963–66)	200 0 0
		£100 East Africa High Commission 3½% Stock (1966–68)	97 10 0
		£400 British Electricity 3½% Stock (1976–79)	396 0 0
		£250 Birmingham Corporation 2½% Stock (1966–71)	250 0 0
		Cash	12 0 0
	£2,808 12 6		£2,808 12 6

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Balance (as per last Account)	25 16 1		
„ carried to Balance Sheet	65 17 11	By Interest received	91 14 0
	£91 14 0		£91 14 0

WILLIAM GEIPEL SCHOLARSHIP TRUST FUND

	£ s. d.		£ s. d.
Capital Account	1,292 18 1	Investment (at cost): £1,583 11s. 10d. 3½% War Stock	1,292 18 1
	£1,292 18 1		£1,292 18 1

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Amount paid to Scholar	50 0 0	By Balance (as per last Account)	72 1 10
„ Balance carried to Balance Sheet	77 10 4	„ Interest received	55 8 6
	£127 10 4		£127 10 4

DAVID HUGHES SCHOLARSHIP TRUST FUND

	£ s. d.		£ s. d.
Capital Account	2,000 0 0	Investment (at cost): £2,045 Metropolitan Water Board (Staines Reservoirs) 3% Guaranteed Debenture Stock (1922 or after)	1,998 15 0
		Cash	1 5 0
	£2,000 0 0		£2,000 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Amount paid to Scholars	90 0 0	By Balance (as per last Account)	177 3 0
„ Balance carried to Balance Sheet	148 10 0	„ Interest received	61 7 0
	£238 10 0		£238 10 0

HUNTER MEMORIAL LECTURE FUND

	£ s. d.		£ s. d.
Capital Account	700 0 0	Investment (at cost): £349 0s. 7d. 5½% Funding Stock (1982–84)	350 0 0
		£369 0s. 10d. 5% London County Stock (1980–83)	350 0 0
	£700 0 0		£700 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Expenditure for Lecture	50 0 0	By Balance (as per last Account)	7 19 0
		„ Interest received	24 14 6
		„ Balance carried to Balance Sheet	17 6 6
	£50 0 0		£50 0 0

I.M.E.A. SCHOLARSHIP FUND

	£ s. d.		£ s. d.
Capital Account	15,202 0 11	Investments (at cost):	
		£5,965 5s. 10d. 3½% War Stock	5,965 5 10
		£4,500 3% Savings Bonds (1960–70)	4,500 0 0
		£1,867 0s. 9d. British Electricity 3% Stock (1974–77)	1,736 15 1
		£1,000 Bristol Corporation 3½% Stock (1961–66)	1,000 0 0
		£1,000 Coventry Corporation 3½% Stock (1960–64)	1,000 0 0
		£1,000 Paisley Corporation 3½% Stock (1958–60)	1,000 0 0
	£15,202 0 11		£15,202 0 11

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Amount paid to Scholars	420 0 0	By Balance (as per last Account)	706 18 2
„ Balance carried to Balance Sheet	791 14 0	„ Interest received	504 15 10
	£1,211 14 0		£1,211 14 0

JOHN DOUGLAS KNIGHT AND ELIZABETH DUNCAN KNIGHT FUND

	£ s. d.		£ s. d.
Capital Account	980 2 9	Investments (transferred):	
		£333 6s. 8d. 3% Savings Bonds (1960–70)	333 6 8
		£624 9s. 6d. 3½% Conversion Stock (1961 or after)	624 9 6
		Cash	22 6 7
	£980 2 9		£980 2 9

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Amount paid to Scholar	50 0 0	By Balance (as per last Account)	52 19 0
„ Balance carried to Balance Sheet	34 16 0	„ Interest received	31 17 0
	£84 16 0		£84 16 0

SIR EDWARD MANVILLE SCHOLARSHIP FUND

	£ s. d.		£ s. d.
Capital Account	5,000 0 0	Investment (at cost):	
		£5,000 3% Savings Bonds (1955–65)	5,000 0 0
	£5,000 0 0		£5,000 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Balance (as per last Account)	57 14 4	By Interest received	150 0 0
„ Amount paid to Scholar	150 0 0	„ Balance carried to Balance Sheet	57 14 4
	£207 14 4		£207 14 4

HENRY NIMMO PREMIUM FUND

	£ s. d.		£ s. d.
Capital Account	150 0 0	Investment (at cost):	
		£253 8s. 11d. 2½% Treasury Stock (1975 or after)	150 0 0
	£150 0 0		£150 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Balance carried to Balance Sheet	12 13 4	By Balance (as per last Account)	6 6 8
		„ Interest received	6 6 8
	£12 13 4		£12 13 4

HENRY NIMMO PRIZE FUND

	£ s. d.		£ s. d.
Capital Account	500 0 0	Investment (at cost): £564 1s. 3d. British Electricity 4½% Guaranteed Stock (1974–79)	500 0 0
	£500 0 0		£500 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Balance carried to Balance Sheet	83 17 8	By Balance (as per last Account)	59 18 4
		„ Interest received	23 19 4
	£83 17 8		£83 17 8

O'GORMAN FUND

	£ s. d.		£ s. d.
Capital Account	2,000 0 0	Investment (at cost): £2,924 9s. 3d. 3½% War Stock	2,000 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Balance carried to Balance Sheet	102 7 0	By Interest received	102 7 0

PAGE PRIZE FUND

	£ s. d.		£ s. d.
Capital Account	100 19 5	Investments (at cost): £50 3½% War Stock	50 19 5
		£56 4s. 5d. British Electricity 3% Guaranteed Stock (1968–73)	50 0 0
	£100 19 5		£100 19 5

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Award of Prize	3 8 8	By Interest received	3 8 8

SIR CHARLES A. PARSONS MEMORIAL SCHOLARSHIP

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Amount paid to Scholars	90 0 0	By Balance brought forward	72 12 0
„ Balance as per Bank Account	33 19 6	„ Interest received	51 7 6
	£123 19 6		£123 19 6

NOTE—The Capital of this Fund is invested by the Charity Commission

PAUL SCHOLARSHIP FUND

	£ s. d.		£ s. d.
Capital Account	4,000 0 0	Investments (at cost): £3,019 3s. 7d. 3½% Funding Stock (1999–2004)	3,000 0 0
		£625 4% Funding Stock (1960–90)	500 0 0
		£562 4s. 7d. British Electricity 3% Guaranteed Stock (1968–73)	500 0 0
	£4,000 0 0		£4,000 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Amount paid to Scholar	60 0 0	By Balance (as per last Account)	113 17 5
„ Balance carried to Balance Sheet	201 8 1	„ Interest received	147 10 8
	£261 8 1		£261 8 1

SALOMONS SCHOLARSHIP TRUST FUND

	£ s. d.		£ s. d.
Capital Account	2,044 15 4	Investment (at cost): £2,485 10s. 7d. Commonwealth of Australia 3% Stock (1972–74)	2,044 15 4
	£2,044 15 4		£2,044 15 4

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Amount paid to Scholars	90 0 0	By Balance (as per last Account)	208 19 0
„ Balance carried to Balance Sheet	193 10 4	„ Interest received	74 11 4
	£283 10 4		£283 10 4

SWAN MEMORIAL SCHOLARSHIP FUND

	£ s. d.		£ s. d.
Capital Account	3,312 15 10	Investments (at cost):	
		£905 10s. 4d. 3% Savings Bonds (1960–70)	995 0 6
		£1,200 British Electricity 3½% Stock (1976–79)	1,194 4 0
		£1,135 17s. 9d. 3½% Conversion Stock (1961 or after)	1,123 11 4
	£3,312 15 10		£3,312 15 10

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Amount paid to Scholar	60 0 0	By Balance (as per last Account)	215 15 7
„ Balance carried to Balance Sheet	264 13 11	„ Interest received	108 18 4
	£324 13 11		£324 13 11

THORROWGOOD SCHOLARSHIP TRUST FUND

	£ s. d.		£ s. d.
Capital Account	1,000 0 0	Investment (at cost):	
		£1,005 Agricultural Mortgage Corporation 5% Debenture Stock (1959–89)	1,000 0 0
	£1,000 0 0		£1,000 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Amount paid to Scholars	37 10 0	By Balance (as per last Account)	75 19 11
„ Balance carried to Balance Sheet	88 14 11	„ Interest received	50 5 0
	£126 4 11		£126 4 11

WAR THANKSGIVING EDUCATION AND RESEARCH FUND (No. 1)

	£ s. d.		£ s. d.
Capital Account	1,700 0 0	Investment (at cost):	
		£2,000 3½% War Stock	1,700 0 0
	£1,700 0 0		£1,700 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Balance carried to Balance Sheet	211 5 0	By Balance (as per last Account)	141 5 0
		„ Interest received	70 0 0
	£211 5 0		£211 5 0

WILDE BENEVOLENT TRUST FUND

	£ s. d.		£ s. d.
Capital Account	3,048 10 2	Investments (at cost):	
		£1,397 18s. 6d. British Transport 3% Guaranteed Stock (1978–88)	1,744 3 11
		£100 London County 2¾% Consolidated Stock (1960–70)	101 8 6
		£250 Commonwealth of Australia 3% Stock (1972–74)	250 0 0
		£500 3½% War Stock	501 9 3
		£381 15s. 1d. 4% Funding Stock (1960–90)	300 0 0
		£200 3½% Conversion Stock (1961 or after)	151 8 6
	£3,048 10 2		£3,048 10 2

INCOME ACCOUNT

	£ s. d.	£ s. d.		£ s. d.
To Grant authorized		92 0 0	By Balance (as per last Account)	37 15 8
„ Balance—Deposit Account	35 10 11		„ Interest received	92 16 1
Tax Recoverable	3 0 10			
		38 11 9		
		£130 11 9		£130 11 9

AIR TRAFFIC CONTROL

Data handling and display systems are centre of interest at Institution symposium

On the 8th April 1960, The Institution held at Savoy Place a symposium on data handling and display systems for air traffic control. The interest in the subject was above expectations: there were 461 registrations and the Lecture Theatre was comfortably filled.

Flight-information processing

At the first session (2.30 p.m.), on 'Flight-information processing for air traffic control', four papers were read. In the chair was Mr. M. J. L. Pulling, Chairman of the Electronics and Communications Section, which organized the symposium.

The first paper was by J. C. Farmer and M. F. Whitney on 'A survey of data handling for air traffic control'. Mr. Farmer stated that the chief purpose of an air traffic control service was to prevent collision of aircraft or between aircraft and obstacles and to expedite and maintain an orderly flow of air traffic. The success with which the air traffic control officer could achieve this depended largely on the extent to which the air traffic control information was up to date, and it was in this direction that improved methods of flight-information processing could make a notable contribution.

The difficulties in air traffic control arose mainly during traffic peaks, particularly when these coincided with bad weather conditions. At present, the average period when an aircraft was in communication with the Southern Air Traffic Control Centre, London, was about 28 minutes. The increase of aircraft speed was shortening this time of control, and the air traffic controller's task was becoming more difficult.

Within the next decade, it could be expected that civil aircraft would be operating in a speed range from 100 to a possible 1700 knots. At present, the computation of estimated arrival times was not difficult; but, as air traffic increased, a larger number of calculations must be carried out in a shorter time and the results must be examined for conflicts. For these purposes, some forms of advanced computer would be necessary. Mr. Farmer considered that many of the techniques involved were now sufficiently well developed for the building of an automatic air traffic control system which would cope satisfactorily with the problems of the next two decades.

A paper by C. G. H. Scholten dealt with 'An electronic computing system for air traffic control'. He described a data-processing system which was now partly completed and in operational use at Amsterdam airport. Received flight information was fed into the system by means of a teleprinter. This information was identified by means of an aircraft address, and corrections to flight plans were fed into the equipment as they became available. Flight information was automatically brought up to date, and the output information was made available on a strip printer. A later version of the equipment would take an automatic input from the radar equipment, carry out conflict search and present the information in a visual display.

Next, J. S. MacMullan, H. S. Bray and J. A. Llewellyn presented 'An experimental electronic data-processing system for air traffic control'. Mr. MacMullan explained the system of data-processing which was in current development for use at the Oceanic Area Air Traffic Control Centre at Prestwick, where it would be used in an extensive experimental programme. The central computer of the system would store a file of flight-progress data on up to 100 aircraft, while a peripheral unit provided for input, extraction and amendment of these data by a number of controllers and communicators.

R. F. Cleaver, P. Sothcott and Group-Capt. F. J. Robinson considered 'An automatic radio triangulation system' in the fourth paper. Mr. Cleaver gave an account of the network of automatic direction-finders which fed signals to a control centre where they were displayed visually on a map. The display system was provided by using individual back-projection cathode-ray units, the directional data being provided from each direction-finding station over land lines or radio links.

Trust the machine

In the ensuing discussion, Mr. W. H. Garnett remarked that evolutionary development was required in flight-information processing, and that the time would come when they must be prepared to put their faith more fully in the machine. He said that the authors of the first paper seemed to imply that the only data-acquisition system was radar. Radar was developed to detect very unco-operative aircraft, but there were many other sophisticated navigational systems which would provide data acquisition.

Mr. D. L. Thomas felt that the continuous automatic reporting of aircraft positions would become an essential part of an automatic air traffic control system, and it would not be satisfactory to report at fixed geographical points as was the case at present. Mr. D. W. G. Byatt declared that in an automatic fixer network an instantaneous display was not necessarily desirable, since an operator might not be constantly watching, and when an emergency call was made there should be no chance of the fix being missed because the operator was not looking at the tube. A number of contributors to

Mr. Pulling opens the symposium

At the front desk are (left to right): M. F. Whitney, J. C. Farmer and J. L. Regan. Behind Mr. Pulling are H. S. Bray (left) and J. A. Llewellyn

the discussion raised the topic of reliability of automatic data-processing equipment and emphasized its importance.

In reply, Mr. Farmer acknowledged that the reliability of automatic data-processing equipment was all-important. Intensive development was necessary for the achievement of this end, and when it was realized they had to be prepared to put more faith in the machine. He agreed that probably insufficient attention had been given in his paper to the other forms of data acquisition which were available besides radar.

Radar data handling

The second session, at 5.30 p.m., comprised five papers on 'Radar data handling for air traffic control'. Mr. C. Williams was in the chair.

The first paper was by G. L. F. Hinckley on 'An experimental system for automatic radar target detection and digital coded plot extraction and transmission'. Mr. Hinckley reviewed a system of processing radar data and transmitting it over long-distance land lines. The technique provided automatic detection of radar targets, the extraction and digital coding of the information in Cartesian co-ordinates, transmission of this data over long-distance telephone circuits, and reconstituting the data at the receiving end either for use as a display or to feed some form of track computer.

The system achieved a very considerable saving in bandwidth and power compared with those necessary to relay the radar information in substantially unchanged form. This saving, of about 500 times, was obtained with only a very slight reduction in accuracy and resolution of the transmitted data. He thought that the method was capable of filling an important place in future radar-data utilization schemes, for it seemed likely that data from widely dispersed radar sites would need to be brought together and correlated at a data-processing centre.

The topic of the next paper, by C. C. Fielding and J. G. Gibbs, was 'Semi-automatic flight control using extracted radar data'.

Mr. Fielding said that the introduction of automatic data-processing and computation in air traffic control would leave the controller free to perform tasks that were best left to the human operator. He envisaged that the operator of an aircraft would feed into the data-processing system a flight plan which would give the origin, route, destination, height, air speed and planned time of take-off, together with other ancillary data. The computer would correlate this plan with all others already filed and adjust it in terms of collision risk etc. It would print out for the operator the revised flight plan, which would be the closest acceptable profile to that which had been filed.

In designing an automatic air traffic control system, it was essential to maintain a proper balance between man and machine. The machine was eminently capable of performing routine assessments, predefined repetitive tasks, computation and presentation of information. The human operator would inject information into the machine, carry out monitoring and make the decisions which could not be defined clearly by the machine. In other words, the machine would be used to aid the controller and so to increase his efficiency.

N. J. Smith and B. W. Oakley gave a contribution on 'Methods of extracting radar data for automatic processing'. In automatic tracking, there was first the need for recognition of the plot as being caused by an aircraft, as distinct from noise or some other signal. It was then necessary to correlate the envelope of the aircraft responses in order to form tracks, the tracks so produced being available for data-processing operations. An automatic data-processing system might be expected to approach the performance achieved by a trained and alert operator, but it might be difficult to exceed the performance of a human operator by a significant margin.

Manual tracking techniques were well tried and reliable, but automatic methods were new and would be better. A manual system required a large number of operators, as the best that was likely to be achieved was six to eight tracks per operator. Automatic tracking equipment would offer a considerable saving in operators, but the equipment would be expensive. Also, a high degree of serviceability would be required, since there would be no economy in exchanging operators for maintenance technicians.

N. J. Smith and P. F. Heggs, in 'A cathode-ray-labelled plan display', examined a system of displaying alpha numeric characters and aircraft velocity vectors on the face of a cathode-ray tube. The patterns were generated as brightness modulation on a small raster. The storage of the patterns was on a small ferrite-core matrix, in which each core corresponded to an element on the raster.

W. F. Ashton in the fifth paper took as his topic 'Fixed-coil display system for data extraction'. He gave details of a P.P.I. display which gave the radar information in its complete form. Other information could be displayed during the inter-trace time, when the electron beam could be deflected to other positions independent of the radar information and thus used to produce an independent inter-trace marker.

More 'noes' than 'yeses'

The discussion was opened by Dr. E. V. D. Glazier. He expressed the opinion that a considerable amount of development would be required before a fully automatic data-handling system would be realizable. He had some doubts about the value of three-dimensional radar, and for height information he preferred to rely on the aneroid barometer.

Mr. D. D. Lipman, from the Ministry of Aviation Air Traffic Control Experimental Unit, said they were concerned with the operational testing of equipments which had been discussed at the symposium. Unreliability would be a very serious obstacle to the successful use of an automatic air traffic control system. Present interest was in providing automatic assistance to traffic controllers and not in going over to full automation of an air traffic control system, although the ultimate aim was to make it fully automatic.

Dr. W. T. Eastwood, contrary to Mr. Lipman, as one of the apostles of the new world, did not believe that human operators were truly reliable. We had to study and understand their limitations, and then we would be able to equate an automatic programme which would reproduce all they could do electronically, without the human errors. Mr. W. Ross referred to the use of redundancy to improve reliability. In any automatic system it would be unwise to rely on a single source of information, for if this should fail the system would fail in its entirety.

Mr. R. Benjamin observed that the human being could handle an amazingly wide range of information but that he did it amazingly badly. A man did very well indeed if he could handle a few bits of information per second. He threw away a tremendous amount of information which he could and should use to do his job properly. An automatic system could be programmed to handle all the available information. Mr. J. W. R. Griffiths commented on the digital store in Mr. Hinckley's automatic target detector. The number of 'yeses' in the store was quite small. Most of the information in the store was in the form of 'no' to questions, and a better utilization of the store capacity might be usefully considered.

The authors then replied to the discussion. Mr. Hinckley viewed his equipment as a data-acquisition system, since it provided the means of matching a number of radar equipments located in different places into a central computer, which might be programmed to filter its supplied data and provide tracks of aircraft in an information store. He agreed with Mr. Lipman on the need for reliability and thought that we must be able to design a system which was good enough to do the job. On the subject of storage in the digital target detector, this was the first machine that he had built, and now the Royal Aircraft Establishment were examining means of improving its efficiency.

Mr. N. J. Smith pointed out that there was a great tendency to compare what a computer *would* do with what a man *could* do, not with what he did. The man made mistakes; the computer made them sometimes. Because the computer was found out and the man was not always found out, the tendency was to put a wrong balance on their relative performances. We should have a traffic control system with both a manual and an automatic part. The automatic part of the machine should have the potentiality to say when it was in trouble; and if the human operator could do better than the machine, then he should take over that part of the traffic problem.

Dividing the burden

The chairman then brought the meeting to a conclusion. He felt it had been a very interesting and exciting symposium. In the attendance had been air operators, air traffic controllers, scientists and engineers who were collectively engaged in dealing with these problems.

The question of the division of the burden between man and machine had been the centre of interest throughout both the afternoon and the evening sessions, and the viewpoints expressed on this division of responsibility had been exceedingly enlightening.

Expressing his own point of view, he said 'Let us go all out to give the air traffic controller the very best means to do the job in the most effective manner and in the shortest possible time'.

C. W.

NEW RADIO REGULATIONS

Administrative Radio Conference, Geneva, August–December 1959

The Administrative Radio Conference faced complex problems when it met in 1959 after an interval of 12 years. During that period, major developments had occurred in relation to the use of radio, and congestion in the 4–27·5 Mc/s range and requirements for radio astronomy and space research were among the topics under discussion. Capt. C. F. Booth, C.B.E., Member, who is Deputy Engineer-in-Chief of the British Post Office and led the United Kingdom Delegation to the Conference, brings out in this article some of the main conclusions of the meeting.

In the 12 years between the Administrative Radio Conferences held in Atlantic City in 1947 and in Geneva in 1959, major developments had been made in the use of radio for communication, navigation and scientific purposes. These included ionospheric-scatter and tropospheric-scatter systems, new radio-navigation systems, radio astronomy and, more recently, the possible use of space vehicles as passive or active repeaters for long-distance communication. In addition, the number of radio-channel requirements for many of the older services had increased. As a result of all these factors, the Geneva Conference faced many complex problems.

200 times 1938

The Conference opened on the 17th August 1959 and was attended by upwards of 700 people, including delegates from 87 member-countries of the International Telecommunication Union, together with representatives of international organizations. The United Kingdom delegation included representatives of the various Government Departments concerned and of the Armed Services, supported by advisers from operating agencies and other bodies.

More than 6000 proposals were examined in detail, and the new Radio Regulations, which cover more than 600 pages, refer to aspects of radio usage on which international agreement is necessary, while the new frequency allocation table covers the range 10 kc/s—40 000 Mc/s. It is of interest to note that this range is nearly four times that of the Atlantic City table (10 kc/s–10 500 Mc/s) and 200 times the corresponding one for the Cairo Conference held in 1938 (10 kc/s–200 Mc/s); no more eloquent example of the growth of radio over the past 20 years could be given.

It says much for the spirit of international co-operation that the task of rewriting the Radio Regulations was completed in four months. The formal signing and closing ceremony was held on the 21st December 1959, when the new Regulations were accepted by the delegates of the 84 countries who signed the agreement. There were a few reservations, mainly in respect of particular parts of the frequency table. It was agreed that the Regulations should come into force on the 1st May 1961.

The frequency allocation table

General—Much effort was spent on that part of the frequency spectrum below 27·5 Mc/s. This caters for fixed, aeronautical, maritime, land-mobile, sound broadcasting (national and international), industrial, scientific and medical, and amateur services. The range 4–27·5 Mc/s is perhaps the most congested part of the whole spectrum, and any easement of one particular service could be provided only at the expense of the other services. Since they are all hard-pressed, and because of the importance of maintaining stability of usage in this part of the spectrum, it was finally decided that no major changes to the Atlantic City frequency table should be made below 27·5 Mc/s.

A frequency-management procedure was adopted for the high-frequency-broadcasting service whereby administrations will submit to the International Frequency Registration

Board four times a year their seasonal broadcasting schedules for the range 5950–26100kc/s, and the Board, with the assistance of administrations, will seek international co-ordination of actual frequency usage on a season-to-season basis.

In considering the use of frequencies in the range 4–27·5Mc/s, it was clearly demonstrated that the congestion was becoming such that positive action would have to be taken during the next few years to reduce demands. It was pointed out that this could be achieved only by the use of alternative means of communication and improved technical characteristics and by the rationalization of circuit usage.

The alternative means for the non-mobile services might, for example, include the greater use of cable (land and submarine), of conventional microwave relay systems, of scatter systems and, in the more distant future, of systems using space-vehicle repeaters. The general problem is to be considered by a group of seven experts, selected from nominations submitted by administrations, assisted by the I.F.R.B. and the Heads of the other permanent organs of the I.T.U. Their recommendations will be examined by the member-countries of the I.T.U.

Of necessity, many changes were made in the table above 27·5Mc/s to cater for the expanding requirements for radio navigation in its several forms, and for new requirements in respect of ionospheric- and tropospheric-scatter systems, radio astronomy and space research.

No major changes were made in the frequency bands allocated in Western Europe for v.h.f. sound broadcasting and for television. The position regarding interference with Band I television reception in the United Kingdom from ionospheric-scatter systems for which frequencies in broadcast Band I are perhaps the best, has, it is hoped, been considerably improved. Systems designed to use ionospheric scatter in Region 1 (Europe, Northern Asia and Africa) over distances exceeding 500 miles must confine their emissions to the three bands 32·6–33, 36·2–36·6 and 39–39·4Mc/s.

In Region 1, allocations for tropospheric-scatter systems have been agreed from 790 to 960Mc/s (in the range 790–860Mc/s on a secondary basis to the broadcasting service) and from 2550 to 2700Mc/s.

World-wide allocations of several bands in the range 1700Mc/s upwards have been agreed for the fixed and mobile services. These are intended primarily for the development of microwave multichannel telephone and television links. Together with the C.C.I.R. recommendations adopted at Los Angeles in 1959, they should facilitate the extension of communication by microwave systems with internationally agreed characteristics.

In the new extension of the table, 10500–40000Mc/s, large-scale provision is made for the fixed, mobile, radionavigation, amateur and space-research services. Although there was no need to define the services in this extended part of the spectrum to the same extent as has been done below 10500Mc/s, it has been generally agreed that international allocations are very necessary.

Radio astronomy—The provision of allocations for radio astronomy provided difficult problems and, although a complete solution was not achieved, considerable progress was made. Agreement to the international reservation of the band 1400–1427Mc/s (hydrogen line) was reached, and there was a good measure of support for earmarking small frequency bands throughout the spectrum for radio astronomy.

In addition to these provisions, it was formally recommended by the Conference that:

(i) administrations, when preparing for the next Administrative Radio Conference, should consider further the question of frequency allocations for the radio-astronomy service;
(ii) the possibility of making a firm allocation in the range 37–41Mc/s be specially considered and that, in the meantime, when assigning frequencies to stations of other services, administrations should avoid, as far as practicable, the bands $38{\cdot}0 \pm 0{\cdot}25$Mc/s and $40{\cdot}68 \pm 0{\cdot}25$Mc/s, which are in use, or are proposed for use, for radio-astronomical observations in certain countries;
(iii) administrations, when drawing up frequency-assignment plans, should leave, as far as practicable, the band 606–614Mc/s free for radio-astronomical observations, or should assign frequencies to stations of other services in this band in such a way as to afford the maximum practicable protection for the radio-astronomy service;
(iv) administrations should notify to the Secretary General the locations of observatories in their countries and those of the bands allocated in the table of frequency allocations that are in use at each observatory; and that the Secretary General should communicate this information to Members and Associate Members of the I.T.U.

The attention of organizations concerned with radio astronomy was called to the need to maintain close co-ordination with their national administrations on matters of frequency usage and to select sites for observatories as remote as possible from sources of radio interference.

Space research—The possible application of space vehicles to communication was appreciated by the Conference, and steps were taken to provide allocations for space-research purposes, as detailed in Table 1. Additionally, it was realized that, as and when the required technical information was available, it would be necessary to make adequate frequency allocations to all categories of space radiocommunication system. To cover this, it was suggested that an Extraordinary Administrative Radio Conference be convened during the latter part of 1963 with an agenda including these basic items:

(a) to examine the technical progress in the use of radiocommunication for space research and the results of technical studies by the C.C.I.R. and other interested organizations;
(b) to decide, in the light of this examination, on the allocation of frequency bands essential for the various categories of space radiocommunication;
(c) to consider whether there is a continuing need for the allocation of certain frequencies for space-research purposes and, if so, to take appropriate action in this regard;
(d) to adopt, if such action is considered desirable, new provisions revising the Radio Regulations to provide for the identification and control of radio emissions from space vehicles, taking into account possible recommendations of the C.C.I.R.

Table 1. Frequency allocations for space research

frequency Mc/s	service
10·003–10·005	part of upper guard band of 10 Mc/s standard frequency transmission; allocated on secondary basis to space service.
19·990–20·010	standard frequency band, allocated on secondary basis to space service.
39·986–40·002	world-wide allocations to fixed and mobile; allocated on secondary basis to space service.
136–137	world-wide allocations to space, fixed and mobile services (eventually the space service will become primary service).
183·1–184·1	Region 1 allocation to broadcasting; Regions 2 and 3 allocation to fixed, mobile and broadcasting; allocated on secondary basis to space service.
400–401	world-wide allocation to meteorological aids and space services; also used by U.S.S.R. and others for fixed and mobile services.
1427–1429	world-wide allocations to space, fixed and mobile services.
1700–1710 2290–2300	world-wide allocations to fixed, mobile and space services; the space service operates on secondary basis.
5250–5255	world-wide allocations to radiolocation and space services. The space service to operate on a secondary basis.
8400–8500	world-wide allocations to fixed, mobile and space services. The space service to operate on a secondary basis.
15150–15250	world-wide allocations to space, fixed and mobile services. The space service is the primary service.
31500–31800	world-wide allocations to space, fixed and mobile services. The space service is the primary service.

The Administrative Council of the I.T.U. will review the situation during its 1962 and 1963 ordinary sessions on the basis of information received from Members and Associate Members of the Union, from the C.C.I.R. and from other interested organizations. Should the Administrative Council decide that there is sufficient justification for the convening of the Extraordinary Administrative Radio Conference in 1963, it will recommend to Members and Associate Members of the Union the date and place for the Conference and its agenda.

Those Members and Associate Members of the Union which launch satellites during the period of space research before the convening of the Extraordinary Administrative Radio Conference referred to above, were invited to keep the Administrative Council, and the relevant technical organs of the Union, informed of the frequencies used and the technical progress achieved in the use of radiocommunication for space-research purposes.

Other Radio Regulations

A great deal of work was done in revising the Radio Regulations to take account of new operating procedures for the mobile services and generally to bring them up to date. With a view to achieving more efficient spectrum usage, improved technical characteristics (in respect of frequency tolerances and spurious radiation) for radio transmitters were adopted. As an example of the steady improvement in frequency tolerances, the limit for fixed stations of power exceeding 500 watts operating in the band 4000–29 700 kc/s was reduced from the Atlantic City figure of ± 30 parts in 10^6 to ± 15 parts. The corresponding figure for the Cairo Conference (1938) was ± 100 parts in 10^6. The new limits are in close accord with the technical recommendations of the C.C.I.R. (IXth Plenary Assembly, Los Angeles, 1959) and will come into force during the next few years.

With a view to the evolution of a more realistic International Frequency List, the procedure for the notification and registration of frequencies by the I.F.R.B. has been amended.

A number of alterations and additions to the Atlantic City definitions of services etc. were made. One change of interest is the adoption of a new nomenclature of frequencies in accordance with Table 2.

Table 2. Nomenclature of the frequency and wavelength bands used in radiocommunication

Band number	frequency range (lower limit exclusive, upper limit inclusive)	corresponding metric subdivision
4	3— 30 kc/s (kHz)	myriametric waves
5	30— 300 kc/s (kHz)	kilometric waves
6	300—3000 kc/s (kHz)	hectometric waves
7	3— 30 Mc/s (MHz)	decametric waves
8	30— 300 Mc/s (MHz)	metric waves
9	300—3000 Mc/s (MHz)	decimetric waves
10	3— 30 Gc/s (GHz)	centimetric waves
11	30— 300 Gc/s (GHz)	millimetric waves
12	300—3000 Gc/s (GHz) or 3 Tc/s (THz)	decimillimetric waves

(i) Band number N extends from $0{\cdot}3 \times 10^N$ to 3×10^N c/s (Hz)

(ii) Abbreviations for adjectival band designations:

Band 4 = VLF	Band 8 = VHF
Band 5 = LF	Band 9 = UHF
Band 6 = MF	Band 10 = SHF
Band 7 = HF	Band 11 = EHF

The International Frequency Registration Board

The functions and duties of the I.F.R.B. have been extended to enable it to play a more effective part in improving spectrum usage, and in assisting new and developing countries to solve their frequency-assignment problems. At the Conference, an election was held for the 11 members of the I.F.R.B. The new Board will take over from the old one on the 1st October 1960 and will serve until after the next Ordinary Administrative Radio Conference.

Summary

Only experience can assess the wisdom of the many major decisions taken at the Conference, but looking back it can be said that all the countries present showed a desire to co-operate and, as a result, much was achieved.

Experience before and during the Conference clearly demonstrated that:

(i) the increasing pressure on, and resulting congestion in, the all-important range 4–27·5 Mc/s will be solved only by the use of much higher frequencies or alternative means of communication for the services in the greatest difficulty;

(ii) the potentialities of space vehicles in providing active or passive repeaters for long-distance communication should be assessed as soon as possible;

(iii) a period of 12 years between Administrative Radio Conferences is too long in view of the scope and speed of the developments taking place in the radio field.

Meeting of the Council on the 23rd June 1960

THE following summary of reports received and decisions reached by the Council of The Institution at their meeting on the 23rd June 1960 is issued on the authority of the President in a form approved by the Council. It will be understood that this report does not purport to be a complete account of the matters discussed at the meeting, as some items are to be the subject of further discussion by the Council.

Membership

The Council gave final confirmation to the election or transfer of those candidates whose names had been published with the May 1960 *Journal*, to become effective from the 1st July 1960. Taking these into account, the total membership at that date was 46 489.

Election of new members of Council

The President conveyed to members of Council the report of the scrutineers, appointed at the Ordinary Meeting held on the 28th April 1960, on the results of the ballot for the 1960–61 Council elections, as follows:

'We beg to report that 3353 ballot papers were returned. Of these, 203 papers were invalid, leaving an effective total of 3150 papers. The result of the voting is as follows:

Elected

PRESIDENT

Sir Hamish D. MacLaren, K.B.E., C.B., D.F.C.*, LL.D., B.SC.

VICE-PRESIDENTS

C. T. Melling, C.B.E., M.SC.TECH., M.I.MECH.E.
B. Donkin, B.A., M.I.C.E.

HONORARY TREASURER

C. E. Strong, O.B.E., B.A., B.A.I.

ORDINARY MEMBERS OF COUNCIL

Members

D. A. Barron, M.SC.
F. H. S. Brown, C.B.E., B.SC., M.I.MECH.E.
Prof. J. M. Meek, D.ENG.
R. L. Smith-Rose, C.B.E., D.SC., PH.D., F.C.G.I.
H. G. Taylor, D.SC.(ENG.)

Associate Member

J. C. Arkless, B.SC.

Associate

J. S. McCulloch.'

Honours conferred on members

The Secretary reported that Her Majesty The Queen had been pleased to confer Honours on several members of The Institution in the recent Birthday Honours List. Details of these will be found on p. 454.

It was also reported that Col. M. O'Connor Horgan, O.B.E., T.D., M.SC., MEMBER, had been appointed a Deputy Lieutenant in the County of London by the Lord Lieutenant, Lord Alexander of Tunis.

Education Discussion Circle

Sir Hamish MacLaren, Chairman of the General Purposes Committee, stated that his committee supported a proposal from the Education and Training Committee designed to fill the need for a central body to co-ordinate the activities of, and to provide liaison between, the various local Education Discussion Circles. A central body, under the general guidance of the Education and Training Committee, would ensure co-operation between the various local Circles by providing a medium through which information could be exchanged on subjects for discussion, speakers and all other matters relating to the programmes of the local Circles.

The Council approved this proposal and agreed that the central body should be called the Education Discussion Forum, the local units retaining the name Education Discussion Circle. Membership of the Forum would be open, free of any additional charge, to all members of The Institution interested in education and training, and non-members concerned with technological education might on certain conditions be affiliated to the Forum on the payment of an annual fee of one guinea.

It was noted that the Education and Training Committee intended to ask the new Forum Committee to undertake the organization of a National Conference and Exhibition of Experimental Apparatus, which it had been suggested should be held at the Loughborough College of Technology in 1961, and to organize any similar projects in future, as this was considered more appropriate than asking a local Circle to carry out this work.

Société Royale Belge des Ingénieurs et des Industriels—75th anniversary

This anniversary was celebrated in Brussels from the 21st to 24th June 1960, and the President had agreed to represent the three senior engineering institutions by attending part of the function, supported by Sir George McNaughton, senior Vice-President of The Institution of Civil Engineers. The President presented to the Belgian society a congratulatory address on behalf of the three institutions. The celebrations were honoured by the presence of His Majesty The King of the Belgians.

Premiums

The Council approved the recommendations of the Papers Committee, introduced by Mr. L. Drucquer on behalf of the Chairman, concerning the award of premiums for the year 1959. Details of these will appear in a subsequent issue of the *Journal*.

'The training of graduates'

The Education and Training Committee received the Council's permission to publish a revised edition of 'The training of graduates', a report of the Joint Committee on Practical Training originally published in January 1957.

Goldup and Page Prizes

The Council had already agreed to accept an offer from Mullard Ltd. to provide funds for the foundation of an annual Goldup Prize for the best of those students who obtained distinctions in all the compulsory subjects of the final year of the Higher National Certificate if these included electronics or telecommunication subjects.

The Examinations Committee had prepared draft conditions of award for the Goldup Prize; and these, together with revised conditions for the award of the Page Prize, which would now complement the Goldup Prize on the heavy-current side, received the Council's approval.

Regulations for the Electrical Equipment of Aircraft

The Council approved, for transmission to the Air Registration Board for promulgation, a revision of Chapter 6, Section J, of the British Civil Airworthiness Requirements prepared by the Committee on Regulations for the Electrical Equipment of Aircraft, which was introduced by Mr. S. E. Goodall, Chairman.

South African Institute of Electrical Engineers

The Council of the South African Institute of Electrical Engineers, in the course of revising their educational requirements, had expressed a wish to use The Institution's Examination syllabus for a qualification for Corporate membership to supplement certain South African degrees and diplomas in electrical engineering. On the recommendation of the Examinations Committee, the Council acceded to this request, with a proviso that, if the South African Institute of Electrical Engineers conducted an examination based on The Institution's syllabus, it would not necessarily be accepted for exemption from the Institution Examination.

The Institution of Architects, Consulting and Civil Engineers, Austria, 100th anniversary

Members of Council were interested to hear a report from Mr. R. H. Phillips, who had attended the celebrations of this anniversary in Vienna from the 1st to 4th June 1960 and had offered congratulations to the Austrian institution on behalf of the President, Council and members of this Institution.

Visit to Poland

The President reported on his visit, with the Secretary, to Poland in April 1960, which they had made as guests of the Polish Government and the Association of National Engineering Societies (N.O.T.). They had had valuable opportunities of discussion with the Minister for Higher Education and of visiting educational and research institutions in Poland, and one encouraging result of their contacts with Polish engineers had been a suggestion that there should be more visits by United Kingdom specialists who would co-operate with their counterparts in Poland in organizing conferences on subjects such as electric traction and automatic control.

S.T.D. in Scotland

THE first town in Scotland to have 2d. trunk calls is Dundee, where subscriber trunk dialling was inaugurated recently. The subscriber trunk dialling system was started in the United Kingdom in December 1958, when Her Majesty The Queen dialled the first trunk call from Bristol. Other towns in the country where the new system has been introduced are Bodmin, Watford and Evesham.

CALL TO UNITE 'SIX' AND 'SEVEN'

REPRESENTATIVES of the engineering industries of 12 West European countries, including the United Kingdom and France, have decided to urge their Governments to take all possible steps to break down the present impasse between the two economic groups, the 'Six' and the 'Seven'. This was disclosed by representatives of the U.K. electrical and mechanical engineering industries on their return to London from a recent conference in Sweden of ORGALIME, the organization of the engineering trade associations in Western Europe.

The United Kingdom was represented by the British Electrical and Allied Manufacturers' Association and the British Engineers' Association, the delegates being W. K. G. Allen, A. I. Baker, E. N. Griffiths, A. W. Berry and S. F. Steward. In a joint statement, the U.K. delegates said:

'The desire for co-operation dominated the discussions in Sweden, and for the first time the French engineering industry came down firmly on the side of industrial and economic co-operation between the two trade groups. It is now generally recognized that only a Western Europe which is united economically can meet effectively the growing competition from both East and West.'

TELEVISION STATION AT SHEFFIELD

THE B.B.C. low-power television station now under construction at Sheffield will be ready for service by the autumn of 1960. It is intended to give improved reception in parts of Sheffield where reception of the Holme Moss transmissions on Channel 2 is unsatisfactory owing to ghost images and interference.

The station, which is located at Tapton Hill, about two miles west of the city centre, will operate without attention, relaying the television signals from Holme Moss.

Programme for coal-fired stations

THE Central Electricity Generating Board has made plans for stepping up its construction programme for coal-fired stations by 1300 MW for 1965 and 1966. This revision of previous estimates was made necessary by the Government's decision to slow down the nuclear-power-plant programme and by the latest forecasts of load during those years.

The Board made applications earlier in 1960 for consent to build a number of coal-fired plants, including those at West Burton and Holme Pierrepont, near Nottingham, each of 2000 MW capacity, and a 1400 MW station near Tilbury.

Component selection and testing machine

A brief account based on a Measurement and Control Section paper (3219) entitled 'An experimental transistor-controlled component selection and testing machine' by T. C. Cardwell, B.Sc.(Eng.), Graduate, J. R. W. Smith, M.Sc., A.Inst.P., and G. H. King, B.Sc., Associate Member. The paper was published individually in April 1960 and will be republished in Part B of the Proceedings. It was read on the 26th April 1960 at Savoy Place before the Measurement and Control Section (a report appears on p. 460). The authors are with British Telecommunications Research Ltd.*

THE key to automatic assembly of electronic equipment lies in a study of the flow of information from design to production. Conventional drawing systems are inadequate for the control of machines, since considerable skill is needed to translate the drawing into machine language, and modifications or corrections occupy excessive time and effort.

Traditional methods of mass production, which are well suited to the manufacture of component parts, often fail in the assembly stage when the numbers required of a particular assembly are small. This is due to the large and varying amount of information required to specify a series of different assemblies.

Mechanized assembly

The introduction of printed wiring and two-dimensional construction simplifies these problems. The circuit interconnections, previously difficult to specify, are now recorded photographically. The assembly data can be coded and handled by data-processing equipment using punched paper tape, punched cards, magnetic drum or magnetic tape, etc. This means that the functions of keeping the records up to date and effecting modifications can be mechanized. Finally, the assembly processes themselves can be mechanized. Machines have been developed which automatically insert many of the commonly used components into the printed-wiring board.

Fig. 1 shows an experimental version of such a machine which can select components from a store, feed them sequentially together with positional information, and assemble them on a printed-wiring board, the whole process being controlled by means of a punched-paper-tape programme.

1 *Experimental component-selection and assembly machine*

Automatic testing

However, should an error have crept into the assembly process due to a faulty component or to a mistake in component loading, it might not be discovered until a functional test had been performed. Subsequent correction would be at least expensive and the whole board might well be scrapped. To avoid this, it is advisable to check each component just before assembly. Thus the full benefits of automatic assembly cannot be obtained without the addition of automatic testing.

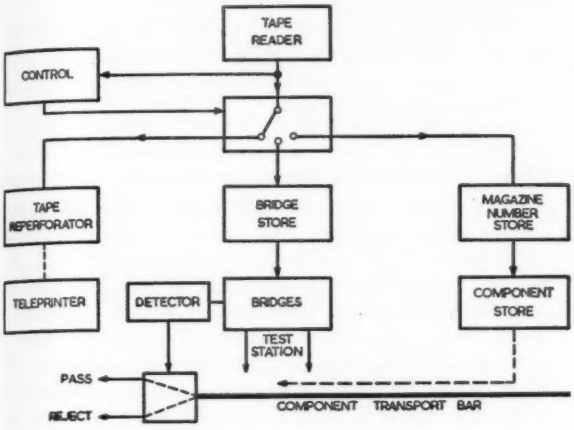
A machine with this facility operates as follows: Components stored in magazines, one for each type of component, are selected as required by operating a solenoid-powered release mechanism situated at the base of each magazine.

The selected component falls onto a conveyor system which carries it to a test station. Here it is stopped, test clips make contact and checks are carried out. Only satisfactory components are allowed to continue to the assembly mechanism, unsuitable ones being rejected and replaced by a further selection.

Although the coded data for this system are for the most part handled automatically, they must be originated by, and occasionally read by, a human being. Thus codes are chosen to be easy to read and write rather than to be of optimum efficiency. The same tapes which control the machines can,

* This article and those following are based on, and written by the authors of, current Institution papers. The authors have been asked to make these articles so far as possible interesting and of appeal to electrical engineers who have no specialized knowledge of the topics, and the content of the articles is not necessarily confined to the subject-matter of the original papers

after suitable processing, be used to aid the control of the production process and to order the required components.



2 *Block schematic of the control equipment*

The control equipment

An outline of the operation of the control equipment for selection and testing is shown in Fig. 2. The tape is fed into a tape reader, the output of which can be routed, on receipt of suitable control characters, to a magazine number store, a bridge store, or a tape reperforator. The required component is then released from the selected magazine, tested according to the information set up on the named bridge (one of several may be chosen), and passed or rejected according to the result.

The tape reperforator gives a copy of the heading of the programme tape and also a list of the results of the tests for subsequent use by the progress-control and quality-control sections of the factory. Tape control of this class of equipment makes the changeover from one type of circuit production to the next, easy and certain. Finally, the input and output tapes are a permanent record of what was actually done.

In constructing these machines, use is made of proven techniques ranging over several branches of engineering and moulded together to produce a complete entity. The co-operation of specialists from diverse fields is essential, and the results serve as a demonstration of the practicability of such an integration.

621.317.73 : 621–52

Extra-terrestrial radio noise

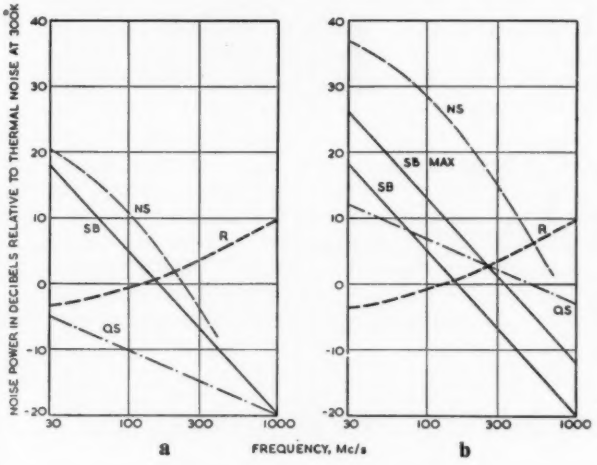
A brief résumé of an Electronics and Communications Section paper (3267) entitled 'Extra-terrestrial radio noise as a source of interference in the frequency range 30–1000Mc/s' by F. Horner, M.Sc., Member. The paper is published this month in Part B of the Proceedings. The author is at the Radio Research Station.

The existence of radio noise from outside the Earth's atmosphere was first reported by Jansky in 1932 during a study of the directional properties of atmospheric noise in the high-frequency range. When his aerial beam pointed in a certain direction and when noise from thunderstorms was weak, he observed a steady hiss, just detectable above the internal noise of his receiver. It is an indication of the subsequent developments in radio techniques that this extra-terrestrial noise is now regarded as an important potential source of interference to radio services over a wide frequency range, and is becoming more and more significant as the sensitivity of receivers is improved.

The science of radio astronomy has developed from Jansky's observation, and has yielded much information about the intensity and spatial distribution of the main sources of noise. This, however, is usually not presented in the most convenient form for the radio engineer, who wishes to know whether extra-terrestrial noise is likely to be a significant source of interference with a particular receiving installation.

Sources of noise

An analysis has been made of the sources of noise in the range 30–1000 Mc/s, in relation to two types of receiving system, one with a simple horizontal dipole aerial and the other with a horizontally-directed pencil beam with a beam-width of 20°. The data are summarized in Fig. 1, in which



1 *Comparison between various sources of noise*

R receiver noise
SB smooth background noise (for the beam aerial, the lower curve shows average noise and the upper one maximum noise)
QS noise from the quiet sun
NS approximate upper limit of noise during noise storms (noise outbursts may be much more intense for short periods)
Note: the solar-noise curves for the beam aerial are for an aerial pointing towards the sun
a horizontal $\frac{1}{2}\lambda$ dipole
b 20° pencil beam

each curve represents the contribution of one type of source to the total noise power in the receiver. Values are expressed relative to the power available from a passive resistance, at a temperature of 300° K, connected in place of the aerial.

The intensity of all types of noise, except that contributed by the receiver itself, decreases as the frequency is raised. The receiver-noise curve of Fig. 1 refers to a system with a well designed conventional type of receiver. With such a system, the smooth background radiation, which originates mainly in the galaxy and which is fairly uniform over a large part of the sky, is normally predominant up to about 150 Mc/s with either type of aerial, and up to nearly 300 Mc/s with the beam aerial when the centre of the galaxy is in the beam. At higher frequencies, the smooth background radiation is below the noise in the receiver itself.

Noise from the sun is never predominant unless there is a solar disturbance. In disturbed conditions, a noise storm may occur, sometimes lasting for several days, and solar noise on a dipole aerial may then be expected to exceed the background noise and the receiver noise up to 200 Mc/s. The corresponding noise on the beam aerial pointing at the sun may be predominant up to 500 Mc/s or higher. When solar flares occur, even greater noise fields can be received, but they usually last for periods of only seconds or minutes.

Noise is also received from a number of so-called point sources, which are mainly outside the galaxy, but these may be disregarded as a significant source of interference except with very narrow beamwidths.

Effect of developments in low-noise receivers

The use of new types of low-noise receiver, based on masers and parametric amplifiers, will extend the frequency range over which external noise can be a limiting factor in a radio service. A considerable improvement in sensitivity will be required before external noise is significant at 1000 Mc/s, with a simple aerial of low directivity. In the design of beam-type systems at this frequency, however, the maximum noise from the sun, even when undisturbed, and from the galactic centre will need to be taken into consideration. 621.391.821

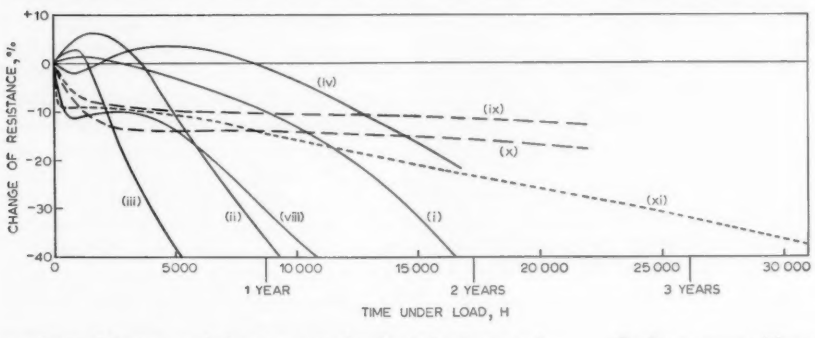
Stability of fixed resistors

A short article based on an Electronics and Communications Section paper (3277) entitled 'The long-term stability of fixed resistors' by H. F. Church. The paper is published this month in Part B of the Proceedings. The author is with the British Electrical and Allied Industries Research Association.

The reliability of electronic equipment, such as military telecommunication apparatus, industrial computers, telephone repeaters or domestic television receivers, is largely dependent on the reliability of the constituent components. Of the components used in such equipment, fixed resistors form a substantial part, and they must maintain their characteristics for long periods of storage or of continuous or intermittent loading, sometimes in damp or otherwise adverse situations.

The Electrical Research Association for many years has been engaged in a fundamental investigation of the causes of failure or drift of value in different types of resistor in various conditions of use. Such knowledge is of importance to resistor manufacturers seeking to improve their products and to equipment designers wishing to select the most reliable type of component for given working conditions.

The work at E.R.A. was at first directed to well established resistor types, and the results are discussed in the paper. These types included carbon composition (grade 2) of both solid-moulded-rod and carbon-loaded-varnish-film construction, high-stability pyrolytic carbon (grade 1), and vitreous-enamelled wire-wound resistors. Work is now proceeding on more recently developed types such as oxide-film and metal-film resistors, and the results on these types will be reported in due course.



1 *Long-term endurance of grade-2 resistors at 70° C and at rated wattage (mean curves for various makes, types and values)*

Carbon-composition resistors

In carbon-composition resistors the resistive element is a synthetic-resin mass in which finely divided carbon is dispersed, sometimes with an inorganic filler. This type of resistor may drift in value appreciably if stored unloaded in a damp atmosphere. The change is a slow increase in resistance, resulting from gradual swelling of the synthetic resin. The drift may in some cases be very large but is recoverable to some extent on subsequent drying.

Under load, uncertain changes occur during the first 500 or 1000 hours, with some makes an increase and with others a decrease of up to 10 or 15%. Thereafter, the resistance may remain fairly steady for a time, with some resistors for several thousands of hours, but ultimately there is a continuous decrease, resulting from gradual thermal degradation and shrinkage of the synthetic-resin binder.

Fig. 1 illustrates these effects for different makes, constructions and values of resistors of this type, each curve being a mean for a group of 6–12 nominally identical resistors. The time for the onset of progressive degradation is very dependent on manufacturing techniques. For example, cold-pressed-rod elements are very sensitive to the thoroughness and nature of the wax-impregnation process after curing. Overloading which causes a rise in the running temperature of resistors greatly accelerates thermal degradation and shortens life.

Vitreous-enamelled wire-wound resistors

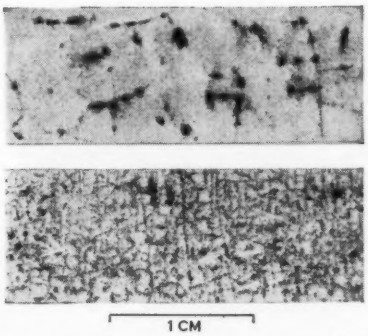
Vitreous-enamelled wire-wound resistors of the type used in electronic apparatus consist of a single-layer winding of superfine nickel–chromium wire on a ceramic tube, the winding being held in place and protected by a smooth coating of vitreous enamel. These resistors usually operate satisfactorily under substantial electrical loading but may fail by open-circuiting during storage.

Especially rapid failure may occur under a light d.c. load in a damp atmosphere. This is due to electrochemical corrosion of the winding in association with crazing or other discontinuities in the enamel coating. Fig. 2 shows the craze pattern on two makes of resistor, both of which gave poor performance during moist-heat cycling with light d.c. load. The prints were obtained directly from d.c. flowing down the cracks and faults. In the absence of crazing, performance was highly satisfactory.

High-stability carbon-film resistors

The resistive element in high-stability carbon-film resistors is a thin layer of carbon deposited on a porcelain tube by cracking a hydrocarbon vapour. A helical groove is subsequently cut in the surface of the tube to adjust the resistance value. The delicate film is protected by a varnish coating or an insulating sleeve.

For satisfactory operation under substantial d.c. load, the alkali content of the porcelain substrate must be very low. Under light d.c. load, fairly rapid open-circuiting may occur in conditions of moisture condensation unless the protective varnish or sleeve is moisture-resistant; the effect is due to electrochemical conversion of carbon to carbon dioxide. Fig. 3 shows an early stage of failure by this mechanism. In



2 *Craze pattern on vitreous-enamelled wire-wound resistors*
a make F, 47kΩ 6 watts
b make G, 15kΩ 6 watts

3 *Early stage of electrochemical failure of a cracked-carbon resistor*

normal conditions of use, these resistors are relatively stable, as their name implies.

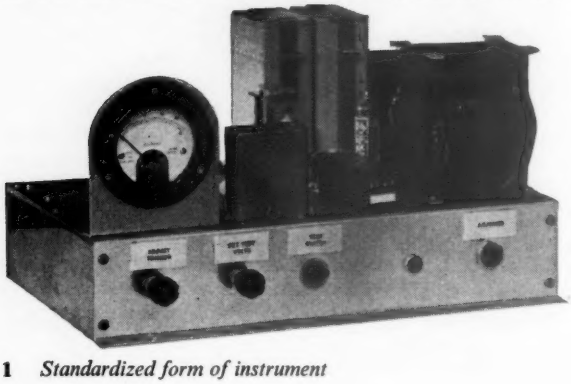
In general, the results of the work show that short-term tests are of little value for assessing the long-term behaviour of resistors. Fine-wire and thin-film resistors are susceptible to electrochemical corrosion effects under low direct voltage and must be adequately protected from moisture. 621.316.84

Lightning-flash counters

A brief résumé of an Electronics and Communications Section paper (3238) entitled 'The design and use of instruments for counting local lightning flashes' by F. Horner, M.Sc., Member. The paper is published this month in Part B of the Proceedings. The author is at the Radio Research Station.

OBSERVATIONS of the frequency of occurrence of thunderstorms have formed a part of meteorological procedures for a long time. As a result, it is known on how many days in each month, on the average, thunder is heard at any one location. This information is not sufficient, however, for many present-day requirements. Electrical power engineers wish to know how many flashes to ground occur, in order to assess the likelihood that an overhead transmission line will be struck. Radio engineers need a detailed knowledge of the electrical activity of thunderstorms, since this is a source of interference to radio services. A warning of the imminent approach of storms would be of value to meteorologists and others.

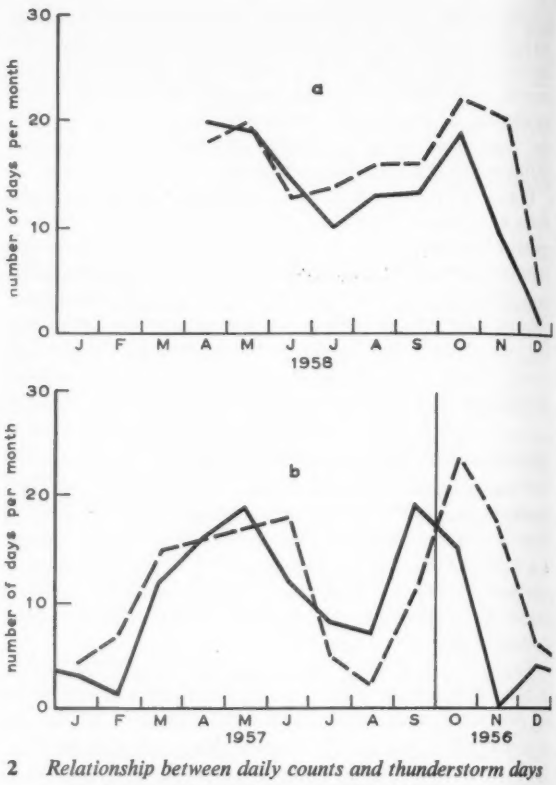
Many attempts have been made to devise an instrument which would record automatically the occurrence of lightning flashes within a defined range. One design which has been investigated in recent years consists of a simple wideband low-frequency radio receiving system which responds to the sudden changes in electric field which accompany lightning flashes. The instrument takes the form shown in Fig. 1. The



1 *Standardized form of instrument*

installation has a standardized aerial and is operated at a known sensitivity which is adjusted by the use of a built-in calibrating circuit. The instrument has been developed for the radio-noise application and it is intended that it should count all flashes rather than only those to the ground. This is done by choosing an appropriate frequency response.

The simplest application of a counter is as an alternative to listening for thunder, for registering the general level of thunderstorm activity. With the experimental arrangement which has been adopted as standard, there is a broad correspondence between days on which thunder is heard and days on which the total number of flashes counted exceeds 100. Fig. 2 shows the correlation observed at two stations where there are frequent thunderstorms.



2 *Relationship between daily counts and thunderstorm days*

—— days on which total count exceeded 100
– – – thunderstorm days per month
a Singapore b Kumasi

Effective range of a counter

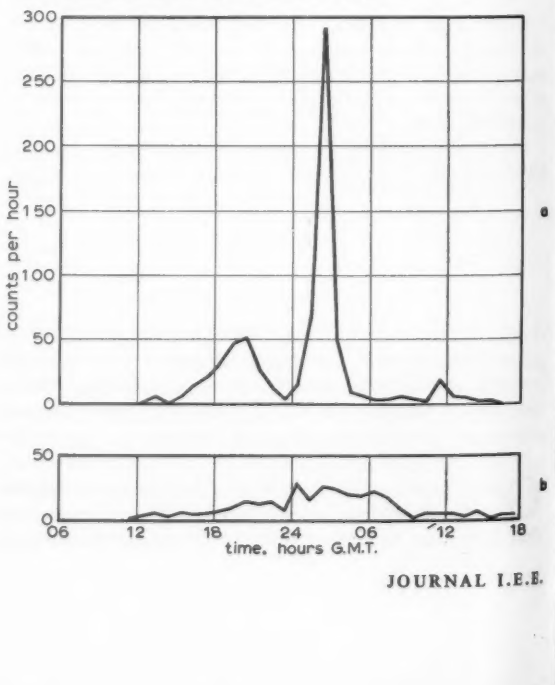
Because lightning flashes vary widely in intensity, it is not possible to design a counter which records all flashes within a specified distance and none beyond. The effective range must therefore be defined and measured in statistical terms, and a useful definition is 'the range within which the number of flashes occurring, over a long period, is equal to the number actually counted'. If this range is known, the records indicate the correct density of the flashes, e.g. the number per square kilometre per hour.

By the use of existing knowledge of the statistical variations in the amplitudes of the field changes due to flashes, techniques have been devised for estimating the effective range from observations of localized storms at known distances. A small network of counters in the south-eastern part of England has yielded data from which it has been deduced that the standard counter has an effective range of 30 km, this being reduced to 13 km by use of an alternative, lower sensitivity.

One difficulty in the interpretation of counter records is that high rates of counting can be caused occasionally, particularly

3 *Performance of local lightning-flash counters*

a local storm 21st–22nd May 1959
b distant storms 27th–28th October 1959



at night, by intense and widespread thunderstorms well outside the normal operational range. A high count over a short period is therefore not by itself positive evidence that there are thunderstorms in the immediate vicinity. A better indication of the true conditions can be gained by studying the variation over several hours. Widespread distant activity leads to a count rate which increases and then declines gradually, and the rate usually remains substantially constant for several hours. A local storm, by contrast, leads to a larger increase confined to a period of the order of an hour, at least in England.

Fig. 3 shows counts obtained with local and distant storms. Although the difference in the maximum count rates is sometimes much smaller than in these examples, the difference in the character of the records is usually quite evident. A continuous record, such as may be obtained by use of a recording milliammeter, is an aid in the interpretation of counter data in these circumstances.

Counters have so far been used only on an experimental basis, and there is a need for further experience, in different parts of the world, both in their operation and in the interpretation of records. Instruments for a more general survey should be standardized, and installed whenever possible on unobstructed sites. 621.317.724 : 621.374.32

THEORY OF SOLID-STATE MASERS

A brief article based on an Electronics and Communications Section paper (3220) entitled 'An introduction to the theory of solid-state masers, with particular reference to the travelling-wave maser' by P. N. Butcher, Ph.D. The paper was published individually in February 1960 and is republished this month in Part B of the Proceedings. It was read before the Electronics and Communications Section on the 7th March 1960 at Savoy Place (see p. 459). The author is at the Royal Radar Establishment.

THE travelling-wave maser is a microwave amplifier with 20–30dB gain, 20–30Mc/s bandwidth and a noise figure of about 0·1dB. The extremely low noise figure is achieved by cooling the amplifier with liquid helium. Conventional microwave receivers have noise figures of the order of 10dB. The addition of a travelling-wave maser as a pre-amplifier can therefore greatly improve the noise performance of a receiver. The travelling-wave maser will be particularly useful in applications, such as radio astronomy, in which extremely low-noise receivers are required.

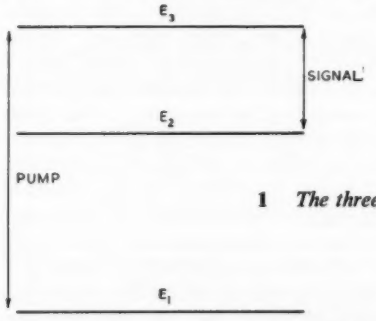
The three-level maser scheme

The word maser is a contraction of 'microwave amplification by stimulated emission of radiation'. To see what this means we consider a typical solid-state-maser material, ruby, which is an aluminium oxide crystal containing a small percentage of chromium ions. The chromium ions belong to the iron transition group of the Periodic Table and behave essentially like magnetic dipoles. The ruby is subjected to a d.c. magnetic field in which the ions have a series of possible energy levels, three of which are shown in Fig. 1.

The ions can be induced to make transitions between any pair of energy levels by irradiating them with a microwave magnetic field having a frequency which is approximately equal to the energy difference divided by Planck's constant. The signal to be amplified induces a transition between levels 2 and 3.

Ions in level 3 drop down to level 2 by emitting a quantum of energy to the signal field; this is the stimulated-emission process. There is a competing process: stimulated absorption, in which ions in level 2 jump up to level 3 by absorbing a quantum of energy from the signal field. The stimulated emission exceeds the stimulated absorption when the number of ions in level 3 is greater than the number in level 2.

The emissive condition is achieved in the maser by pumping ions up from level 1 to level 3 with an auxiliary microwave field called the pump. The pump is most effective in ruby containing about 0·05% chromium, which is cooled with liquid helium. Ruby containing 1% or more chromium is



1 *The three-level maser scheme*

unaffected by the pump and remains absorptive at the signal frequency. Thus, as far as the signal is concerned, there are two types of pumped ruby: active crystal (0·05% chromium) and passive crystal (1% chromium). Both types are used in the travelling-wave maser.

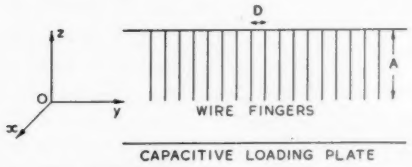
The travelling-wave maser

Most of the solid-state masers built to date have consisted simply of a piece of active crystal placed in a microwave cavity. However, the cavity maser has a narrow bandwidth and must be used in conjunction with isolators or a circulator to prevent oscillations occurring when there are small reflections in the waveguide feeds.

These difficulties can be overcome by distributing both active and passive crystals along a suitable waveguide. High gain can be achieved by using a waveguide with a low group velocity so that the signal energy travels slowly along the structure. Calculation shows that the group velocity must be about 1% of the velocity of light. The comb waveguide shown in Fig. 2 slows the signal down to this extent.

It consists of an array of parallel wires which are short-circuited at one end and capacitively loaded at the other.

This type of waveguide has been used successfully in a travelling-wave maser at the Bell Telephone Laboratories. The comb is contained in an ordinary rectangular waveguide which carries the pump power.



2 *The comb waveguide*

Non-reciprocal gain

The chromium ions behave essentially like magnetic dipoles, and, from a classical point of view, they may be regarded as precessing about the d.c. magnetic field. The ions couple strongly to a circularly polarized microwave magnetic field which rotates in sympathy with their precessional motion, and very weakly to one which rotates in the opposite sense. This non-reciprocal behaviour of the ions is exploited in the travelling-wave maser to achieve non-reciprocal gain.

The comb is loaded with ruby as shown in Fig. 3. Active crystal is placed on one side of the comb and passive crystal on the other. An analysis of the microwave magnetic field in the comb waveguide shows that it is circularly polarized and rotates in opposite senses on the two sides of the comb. Moreover, the sense of rotation is reversed on both sides of the comb when the direction of propagation is reversed. Hence, for one direction of propagation the signal couples strongly to the ions in the active crystal and is amplified, while for the opposite direction of propagation the signal couples strongly to the ions in the passive crystal and is attenuated.

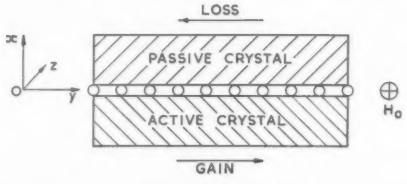
The loading can be adjusted so that the reverse loss exceeds the forward gain. The amplifier cannot break into oscillation in this case, however large the reflections in the input and output waveguides may be.

It is impossible to take advantage of the non-reciprocal behaviour of the chromium ions in cavity masers because the microwave magnetic field in a cavity is linearly polarized. Non-reciprocal gain is achieved in cavity masers by adding isolators or a circulator outside the cavity.

Bandwidth and noise

The gain of the travelling-wave maser falls off as the signal frequency departs from the resonant frequency of the 2–3 transition (see Fig. 1), because the stimulated emission is reduced. The half-power bandwidth of the transition is typically about 60 Mc/s. At 20 dB gain the amplification bandwidth is 42% of the transition bandwidth, i.e. 25 Mc/s. The amplification bandwidth of a cavity maser with 20 dB gain cannot exceed 20% of the transition bandwidth and is usually much less.

In addition to making transitions under the influence of the signal field, the ions can also drop spontaneously from level 3 to level 2 (see Fig. 1). The quanta emitted in this spontaneous-emission process constitute the noise output of the amplifier.



3 *The comb structure loaded with ruby*

Most of the noise output comes from the ions in the active crystal because the ions in the passive crystal do not couple to waves travelling towards the output. A calculation of the noise figure yields a value of about 0·1 dB when the amplifier is cooled with liquid helium. Measurements carried out at the Bell Telephone Laboratories have confirmed this almost ideal noise performance. 621.375.9

Synopses of papers

THE following are synopses of papers published in the *Proceedings* which have not been read at Institution meetings and which have not been reviewed in the *Journal*. They are included here primarily for reference. The papers have not been published individually, as have those for reading at meetings, but reprints will be available in due course

Gas-insulated power transformers

A synopsis of a Supply Section paper (3288) with the above title by G. Camilli. The paper will be published in Part A of the Proceedings. The author is with the General Electric Co., Massachusetts, U.S.A.

POWER transformers have reached such a degree of perfection that it seems unlikely that there is room for substantial improvement in any fundamental characteristic. However, the insulation of conventional transformers is in the main dependent on a liquid which is not only inflammable but has other undesirable characteristics. The substitution of gas for oil as the insulating medium eliminates the undesirable characteristics of the latter, and, in addition, gas-insulated units have other advantages.

Of the various gases having desirable properties for use in modern equipment, sulphur hexafluoride is prominent. It is produced commercially in the United States.

After reviewing the advantages of gas-insulated transformers, the author examines the fundamental characteristics of this electronegative gas, and experimental data are presented of its electric strength relative to oil. Of considerable interest to the designer is the peculiar behaviour of gases subjected to impulse tests. It is shown that, for the same low-frequency electric strength, gas-insulated units have lower impulse strength than oil-filled transformers. This deficiency, however, can be overcome with liberal margins of

safety if gas-insulated transformers are protected with modern lightning arresters.

The cooling of these new transformers is by forced circulation of the gas. The thermal capacity of gas-insulated units is, of course, somewhat lower than that of oil-filled units; theoretically, it would appear that, on this account, the overload capabilities of gas-filled transformers might be much lower than those of oil-filled units. This apparent deficiency is partially nullified by the fact that the thermal-ageing characteristic of conventional class-A materials used in the construction of transformers is higher in gas than in oil. Consequently, the overload capabilities of gas-insulated units compare quite favourably with those of oil-filled units cooled by forced circulation of the liquid. 621.314.2

Controlled rectifiers using transistors

A synopsis of an Electronics and Communications Section paper (3281) entitled 'The design of controlled rectifiers using triode transistors' by E. E. Ward, Ph.D., Associate Member. The paper will be published in Part B of the Proceedings. The author is in the Electrical Engineering Department, University of Birmingham.

The author deals with polyphase rectifiers in which the switching element is a complementary combination of a *p–n–p* and an *n–p–n* transistor. The stability conditions for the open and closed states of this switch are investigated graphically, leading to the calculation of the voltage drop when conducting. There is a sharp upper limit to the permissible current. Tests on a 3-phase controlled rectifier are described. 621.314.63 : 621.382.333.3

Sunspot-cycle effects on frequency

A synopsis of an Electronics and Communications Section paper (3285) entitled 'Sunspot-cycle variations in the discrepancies between predicted and observed frequencies for use in radio-communication' by R. J. Hitchcock, M.A., G. O. Evans, B.Sc., Associate Members, and R. Naismith, Member. The paper will be published in Part B of the Proceedings. Mr. Hitchcock is with Cable and Wireless Ltd., Mr. Evans in the Post Office Engineering Department, and Mr. Naismith at the Radio Research Station.

A marked variation occurs over the sunspot cycle in the discrepancies between predicted F2 4000km-m.u.f. and the observed times of fade-in and fade-out on an 18·4 Mc/s Bombay–London circuit. This is particularly marked in summer and is attributed to the influence of the sporadic-E layer, although there is no marked sunspot-cycle effect attributed to this layer.

Any assessment of the accuracy of predictions analysed on the assumption of F-layer propagation must be considered in relation to the phase of the sunspot cycle to which it refers. 621.391.812.44

Transistors for regulation of aircraft power systems

A synopsis of a Utilization Section paper (3266) entitled 'Transistorized regulation and control of aircraft electrical power systems' by K. Bacon, Graduate. The paper will be published in Part A of the Proceedings. The author is at the Mullard Research Laboratories.

The author explains an attempt to replace with solid-state devices the carbon-pile regulators and electro-mechanical protective circuits in a representative aircraft's power system. A complete 2-generator d.c. system has been built and found to give substantial improvements in performance over a conventional system. The only electromechanical device used was a 400amp d.c. contactor. A new approach to generator protection, relying on a knowledge of its excitation characteristics, is also described. There seems to be no reason why similar principles should not be applied to a.c. systems. 621.316.722 : 621.313.2

Two-phase induction motor used as a servomotor

A synopsis of a Measurement and Control Section paper (3280) with the above title by D. Connelly, B.Sc., Associate Member. The paper will be published in Part A of the Proceedings. The author is with Sangamo Weston Ltd.

The performance of a 2-phase induction motor used as a servomotor depends on the alteration of the machine from 2-phase to single-phase operation. This can be effected in three ways. Two depend on change of applied voltage and the third depends on alteration of the relative disposition of two stators in a specially constructed machine.

The speed/torque relationship for the three conditions is deduced from the initial assumption that the flux-density distribution is sinusoidal in space and time. The analysis reveals that single-phase motors have a maximum speed dependent on the rotor resistance/reactance ratio as well as the frequency. It suggests a more appropriate alternative definition of synchronous speed than that commonly accepted, namely as that speed at which the unidirectional torque becomes zero.

Theoretical performance curves of the machine as a 2-phase motor, as a single-phase motor, and in the intermediate condition between these two extremes, are given, for various assumed resistance/reactance ratios, as a function of the parameter which alters the machine from 2-phase to single-phase operation. Comparison between theoretical and experimental curves is made.

The resistance/reactance ratio of the 2-phase servomotor, required for effective speed control near zero speed, is demonstrated by the curves. 621.313.333 : 621–526

PAPERS AND MONOGRAPHS

published individually this month

Papers accepted for reading at meetings and monographs are first published individually and are republished later in the Proceedings of The Institution; as soon as the separates are available, they are described in this feature. The papers are supplied free of charge; the price of a monograph is 2s.

In addition, reprints of papers read at meetings, including the discussions thereon, and of papers not read at meetings, become available, price 2s., within two months of their appearance in the Proceedings.

Applications quoting the serial number of the paper, monograph or reprint as well as the author's name and accompanied by a remittance where appropriate should be addressed to the Secretary of The Institution. For convenience, books of five vouchers for this purpose can be obtained in advance, price 10s.

Those who obtain a copy of a paper published individually are urged—if they do not take the Part of the Proceedings in which it will be republished—to apply in due course for a reprint, as this is the final and correct version and includes the discussion.

PAPERS

Rapid methods for ascertaining whether the activity of a weak radioactive sample exceeds a predetermined level *Paper* 3258M, *Part B*

E. H. COOKE-YARBOROUGH, M.A., *and* R. C. M. BARNES, B.SC.(ENG.)

THE authors consider methods of determining whether the mean rate of occurrence of random events, such as radioactive disintegrations, is greater or less than some given tolerance rate. The most efficient technique is one which makes this determination in the shortest time and with an acceptably low probability of error. Sequential test procedures minimize the sample size by observing the random process until some terminating condition is satisfied.

The performance of several sequential tests is investigated, with particular reference to conditions encountered in monitoring radioactive contamination on the hands. The most efficient of these tests is one which measures the difference between the number of events actually observed and the number expected at tolerance rate. In conditions likely to be encountered in routine monitoring for radioactivity on the hands, this method gives a five-fold saving in time over the technique now in use.

Universal non-linear filter, predictor and simulator which optimizes itself by a learning process *Paper* 3270M, *Part B*

PROF. D. GABOR, F.R.S., W. P. L. WILBY, PH.D., *and* R. WOODCOCK, PH.D.

A MACHINE is described which consists of a universal non-linear filter, which is a highly adaptable analogue computer, together with a training device. The analogue machine has 18 input quantities, from which it can compute in about 2·5 millisec 94 terms of a polynomial, each term containing products and powers of the input quantities, with adjustable coefficients, and can form their sum. The input quantities may be, for instance, 18 past samples of the values of a stochastic variable which is fed into the machine, and the result of the computation is an output function which contains 94 free variables.

The training device optimizes the output by successive adjustment of the variable coefficients, until it has approached a target function as closely as can be achieved with a polynomial of 94 terms, by the criterion of the least mean-square error. This is done by repeatedly feeding into the machine a record of the stochastic process, long enough to be representative, and adjusting the variable coefficients, one at a time after each run, by a strategy which ensures that the error will monotonically decrease from run to run.

In order to make the machine an optimum filter, it is trained on a record of a noisy process, together with a target record which contains the signal only. It is taught as a predictor by taking as the target function a value of the stochastic process advanced by a certain time interval beyond the last value which goes into the input.

Short-circuit ratings for mains cables *Paper* 3284S, *Part A*

G. S. BUCKINGHAM, B.SC.(ENG.)

RESEARCH work carried out by the E.R.A. has enabled distribution engineers to assess with greater accuracy the strength of paper- (or cambric-) insulated cables to resist the forces arising from severe short-circuits.

E.R.A. Report Ref. F/T195 describes the research work which has been carried out over a number of years; the present paper interprets the results of the research and provides curves which illustrate the short-circuit currents which can be safely carried by such cables at working voltages up to 11 kV.

Protection of high-voltage insulators from power-arc damage *Paper* 3289S, *Part A*

A. E. GUILE, PH.D., B.SC.(ENG.)

THE author summarizes the results and conclusions of an experimental investigation into the reduction of damage by power-follow-through arcs on various types of high-voltage insulator. Where normally used, protective fittings of the usual type were tested, and suggestions are made for modifications to the fittings so as to give greater protection. The effects of wind were taken into account. Only 11 kV and 33 kV insulators were tested, but the investigation was designed to obtain information which can be applied to the larger units at the highest voltages.

Since any application in service of these results must depend on economic considerations, some information is included on the amount of arc damage to high-voltage insulators occurring in service, both in this country and abroad.

Radiocommunication in the power industry *Paper* 3290S, *Part A*

E. H. COX *and* R. E. MARTIN, D.F.H.

THE authors review the present position with regard to the uses of radiocommunication in the electricity supply industry and call attention to some of the problems that have been encountered in the planning and operation of mobile and fixed-to-fixed v.h.f. radio links.

They deal with the topic from a general point of view, as the wide variety of applications and special requirements cannot be discussed in detail in a single paper.

MONOGRAPHS

Signal flow-graph analysis and feedback theory *Monograph* 388E

R. F. HOSKINS, M.SC.

THE solution of a system of simultaneous linear equations may be obtained by inspection of an associated system of nodes and connecting branches called a 'signal flow-graph'. This provides an alternative to conventional algebraic methods which is of particular interest in the case of network analysis, since the flow graph can be set up directly by inspection of the network without having to formulate the associated equations.

In the paper, the formal theory of flow-graph analysis is developed and applied to certain aspects of feedback theory, and it is shown that the classical results of Bode can be obtained and generalized relatively simply by this approach.

Received-amplitude distribution produced by radio sources of random occurrence and phase *Monograph* 389E

W. C. BAIN, M.A., B.SC., PH.D.

A THEORETICAL calculation is given of the amplitude probability distribution to be expected on an ionospheric v.h.f. forward-scatter circuit due to reflections from meteor trails alone. The analysis is based on the addition of a large number of signals with a frequency of occurrence inversely proportional to the square of their amplitude, and will therefore apply to other problems in which this relation holds.

The calculated distribution is compared with a small number of practical results, and a method is outlined for deriving the relative proportion of meteoric and turbulent-scattering components in the signal.

A brief review of the theory of paper lapping of a single-core high-voltage cable *Monograph* 390S

P. G. PRIAROGGIA, DR.-ING., E. OCCHINI, DR.-ING., *and* N. PALMIERI, DR.-ING.

A BRIEF outline of the theory of the lapping operation for high-voltage single-core paper-lapped cable is given, showing the stability conditions which the insulation thickness must satisfy in order that bending of the cable on the reel or capstan does not cause any damage to the insulation itself.

An example of the design of a high-voltage cable is considered, showing the application of the theory outlined and its practical use.

New type of piezoelectric flexural vibrator in the form of balanced cantilevers *Monograph* 391E

SHEILA AYERS

THE flexural vibrator, designed to vibrate at about 1 kc/s, basically consists of identical cantilever arms extending from a common area to form a symmetrical element. Two distinct shapes have been considered—the H and the 'zigzag'. Some of the H elements have uniform cross-section, while others are arranged to have most of their mass at the free ends in order to reduce the frequency for a specimen of given length. The 'zigzags' have folded arms of any number of sections (increasing the number of sections reduces the frequency).

The theory of the various forms and their frequency equations are derived. Conditions for perfect balance of the reactions at the supports are discussed.

Measurements have been made on H and 'zigzag' forms made from quartz slices $ZYb\Phi(\Phi = 0 - 10°)$ and on 'zigzag' form from EDTXY*ltl*Φ, 90°, 90°. Frequency, temperature behaviour, Q-factor and displacement patterns of the elements are compared with theory. Since some of the conventional driving methods proved unsatisfactory, a short section is included on circuits.

Chain codes and their electronic applications *Monograph* 392M

F. G. HEATH, B.SC., *and* M. W. GRIBBLE, B.SC.

A TYPE of binary digital code is described which is easily generated by computer circuits. The important properties of these codes are described, and various electronic applications are enumerated.

Frequency-response analysis of the stabilizing effect of a synchronous-machine damper *Monograph* 393S

A. S. ALDRED, M.SC., PH.D., *and* G. SHACKSHAFT, B.ENG., PH.D.

THE authors describe the application of frequency-response concepts to the analysis of a synchronous-machine damper in so far as it affects the stability of the machine. The analysis of damper effects is based on Park's equations. Small-displacement theory is introduced to organize the equations into the correct form for frequency-response computation.

Nyquist diagrams are used to show the stabilizing effect of a damper and to illustrate the method of optimizing damper parameters.

OBITUARY

LEONARD BURDES

Leonard Burdes, B.SC.(ENG.), who died on the 24th March 1960 was born on the 4th February 1903. He was educated at Northampton Town and County Public School, and at Sunderland Technical College part-time while receiving practical training with George Clark Ltd.

After further training with Metropolitan-Vickers for two years and being employed as a junior engineer, he became assistant power sales engineer in 1928 with the Bristol Corporation Electricity Department, in 1936 being appointed power sales engineer. Soon after nationalization he was appointed section head (special agreements) at the South Western Electricity Board headquarters and in 1950 was transferred to the chief engineer's department, where he stayed until he was forced to retire through ill health in 1955.

His hobbies included swimming, bee-keeping and poultry-keeping. He had a quiet and retiring personality, but in spite of this his tact, consideration, and perhaps above all his integrity, won him the admiration of his colleagues and the respect and loyalty of his subordinates. He is survived by his widow, a son and a daughter.

He joined The Institution as a Student in 1924 and was elected an Associate Member in 1931 and a Member in 1943. He served as honorary secretary of the Western Centre from 1940 to 1948, as vice-chairman in 1948–49 and as chairman in 1949–50. He was awarded a Student premium for his paper entitled 'Electric lifts' which was published in the *Journal* in 1929. He was an Associate of the Chartered Institute of Secretaries.

BADEN JOHN EDWARDS

Baden John Edwards, M.B.E., whose death on the 16th February 1960 was learnt of with great dismay by his friends in the electronics industry, was born on the 26th August 1912. He was educated at Plum Lane State School, Plumstead, and at Woolwich Polytechnic; receiving practical training with Standard Telephones and Cables, Woolwich.

In 1931, on the completion of his training, he joined A. C. Cossor, London, as assistant test equipment engineer, returning to Standard Telephones and Cables in 1934 as assistant development engineer.

He joined Pye Ltd., Cambridge, as assistant chief television engineer in 1935, becoming chief television engineer in control of all television development and research two years later. In 1938 he was appointed chief engineer, in 1946 technical director, responsible for the technical control of the laboratories, and in 1948 technical director on the board, with the additional responsibility of controlling the general activities of the main and subsidiary companies.

He seemed in many respects to be far ahead of his contemporaries in forward thinking in the many different applications of television. During the Second World War he made an important contribution, with Sir Robert Watson-Watt, to the development of radar. After the war he carried out important research in the field of colour television. He played a significant part in the early development of industrial television, not only in offices but also for critical areas in an atomic pile, and was far-sighted in his ideas about the use of educational television, especially in the less well developed countries of the world. Underwater television too owed much to his original thought, and he tried out the first underwater cameras at Portsmouth.

His colleagues were always struck by the imaginative ability which enabled him to pursue projects such as these. He was a pioneer in everything he undertook; and England, which needs pioneers so greatly, will sadly miss someone it can ill afford to lose.

He joined The Institution as an Associate Member in 1943 and was elected a Member in 1950. He served as vice-chairman of the Cambridge Radio Group in 1944–45. His papers entitled 'The

Obituary (continued)

design of television receiving apparatus' and 'A survey of the problems of post-war television' were published in the *Journal* in 1941 and 1944 respectively. He was appointed a Member of the Order of the British Empire in 1946. B.

ARTHUR STAFFORD KETTLE

Arthur Stafford Kettle who was born on the 6th April 1891 died on the 26th April 1960.

He was educated at Finsbury Park College, London, and at St. Peter's School, Bournemouth, and received his technical training part-time at Bournemouth Technical College. He served a three-year apprenticeship with Bournemouth and Poole Electricity Supply Co. and was shift engineer at Christchurch generating station for a further six months before going to Rugby in 1911 to join the British Thomson-Houston testing department. In 1915 he was appointed chief-of-test, a position he held until 1928 when he became service engineer and during the succeeding 13 years travelled widely for 'on the spot' investigations of technical problems associated with the performance of capital plant installed at home and abroad.

During the Second World War he was seconded for duty as manager of the Brimsdown works, which was at that time engaged on the production of valves and electronic components for the Services. He returned to Rugby in 1946 and two years later became manager of the construction department, responsible for plant erection and maintenance outside the Rugby factories, a position which he held until 1956. He continued until his retirement in 1957 as consultant to the construction department and to the service engineers' department.

He was a man who would 'have things right', and the almost judicial qualities he brought to unravelling the vexed problems that surround the failure of equipment in service inspired confidence in customer and colleague alike. He was keenly interested in youth and for many years interviewed, advised and guided recruits to the engineering profession. He will be widely remembered by the great number of professional engineers scattered throughout the world who will recall with appreciation their training 'in test' under the inspired leadership of their former chief. He is survived by his widow and a son.

He joined The Institution as a Student in 1913 and was elected an Associate Member in 1917 and a Member in 1921. G. S. C. L.

GEORGE SHEARER

George Shearer, B.SC.(ENG.), who was born on the 14th November 1897 died on the 25th April 1960, following a recent operation, after 39 years of unbroken service to the Royal College of Science and Technology, Glasgow, at which he had been a student. He was educated at Mey Public School, Caithness, and at Castletown Higher Grade School before entering the college in 1915.

He served in the Royal Navy during the 1914–18 War, returning to the college in 1919. In 1921, on gaining the B.Sc.(Eng.) degree and the diploma of the college, he became a demonstrator and in 1924 assistant lecturer. His periods of practical training were spent with the British Thomson-Houston Co., Rugby, where he developed an interest and knowledge in rotating machines which were perhaps rivalled in later years by his fascination with symmetrical components. These were his work and his hobby alike.

He was appointed senior lecturer in 1945 and principal lecturer in 1956, and served on the Board of Studies.

His characteristic kindliness, as well as his outstanding ability as a teacher, brought him not only repute but hosts of friends. He never forgot his students and they will never forget him. They were fortunate to have had such a great teacher, and the college such long and devoted service.

He joined The Institution as a Student in 1920 and was elected a Graduate in 1926, an Associate Member in 1928 and a Member in 1951. F. M. B.

SOME RECENT BOOKS

CATHODIC PROTECTION

L. M. APPLEGATE

McGRAW-HILL. 1960. 229 PP. £3 10S.

CATHODIC PROTECTION

J. H. MORGAN

LEONARD HILL. 1959. 325 PP. £2 17S. 6D.

THE book by Applegate covers the basis of cathodic protection, measurements and surveys, coatings, protection equipment and practical applications to buried and immersed structures.

It is a disappointing work, because a wealth of practical information, collected largely during an inspection assignment with the United States Army, is presented uncritically and, at times, without an understanding of fundamentals.

Inconsistency in expressing the polarity of potentials will cause difficulty for the beginner. Signs are dropped indiscriminately, and a negative potential is said to increase when it becomes more negative, and vice versa (see p. 67 for examples).

The division of the resistance of a length of pipe coating by the surface area is suggested as a step towards calculating the coating resistivity (p. 57). This is probably because of the misleading practice (also followed by Morgan) of quoting the resistance through unit area of coating in ohms/ft^2 instead of ohm-ft^2. It is less easy to understand why, on p. 31, it is stated that the silver/silver-chloride half-cell contains no liquid electrolyte. It must, although the water in which the tests are made can be allowed to enter the cell to form the electrolyte. Use of this half-cell in either fresh or salt water is recommended, and its potential is stated to three significant figures, but the variation with the chloride content of the electrolyte is not mentioned.

The preface claims that cathodic protection can be applied by following the instructions in the text 'whether or not the engineer fully understands their theoretical bases'. In the opinion of this reviewer, such attempts are unlikely to give good results, particularly in this country, where many structures are laid close together and a large part of the problem is to avoid damage to neighbouring structures by stray protection current. This difficulty is hardly referred to.

Morgan does not claim to have written a complete 'do-it-yourself' manual. However, his volume can be recommended both to the experienced and as a starting-point for the beginner. The introduction covers sufficient electrochemistry for the purpose and is clearly written.

Electrode resistance and potential distribution in the soil are treated mathematically, where appropriate, and practical examples are given in the chapters on protection methods, in which buried and immersed structures, and structures containing electrolytes, are considered separately. Representative examples of instruments and their use are given, and the measures necessary to prevent the corrosion of neighbouring structures are outlined. The section on economics shows the trend of costs with the various parameters, including the intended life of the installation.

This publication is relatively free from errors but, in the Table on p. 275, the signs of the half-cell potentials are wrong. J. H. GOSDEN

ELECTRICAL AND ELECTRONIC DRAWING

C. J. BAER

McGRAW-HILL. 1960. 218 PP. £2 6S. 6D.

THIS book is intended for electrical draughtsmen and as a reference for teachers and engineers. To make readers conversant with drawings in current use, the author has intentionally given examples illustrating non-standard symbols etc. This practice hinders standardization and tends to confuse the learner.

The chapter on schematic diagrams is comprehensive, but more emphasis could have been given to functional presentation instead of commending the equal spacing of tram-lines on a large diagram and showing how to avoid diagonal lines on a flip-flop circuit. A brief mention is made of basic processes involved in etching printed circuits, but little is said about drawing methods.

The final section on graphs is useful, but as all the preceding chapters and exercises invoke American Standards, which are at variance with British Standards, the volume is unlikely to be of practical value to the majority of students and engineers in this country. L. A. DYER

ORGANISATION ET FONCTIONNEMENT DES MACHINES ARITHMÉTIQUES

H. BOUCHER

PARIS: MASSON. 1960. 427 PP. 70NF

LIKE most French writing, the present work is characterized by lucidity combined with philosophical overtones. A good balance is struck between topical descriptions of actual modern computers (which may well be obsolescent in a year or two) and what may be termed computer philosophy.

Chapter 1 notices some fundamental points regarding the nature and use of numerical calculation, while chapter 2, entitled 'Langage des machines', deals mainly with numerations and character and word representations.

The next 50-odd pages are devoted to memory technology; here, as elsewhere, the treatment is qualitative and can be followed by any reader with a knowledge of Ohm's law and of the general features of valves and transistors (not that this is even remotely a simplified, 'popular' book). After a brief account of elementary Boolean algebra, computer unit circuits and operations are classified and described, followed by a similar treatment of coders, decoders, monitors, control units and programmes.

Chapter 8 discusses breakdown protection and detection, and the final section considers the historical evolution and possible further developments of computers, all the commercially available types being summarized in data sheets in an end-pocket.

The volume is equally suitable for engineers interested in the industrial and commercial potentialities of computers, and for students wanting a good introductory survey of what is rapidly becoming an autonomous branch of science. D. E. BROWN

ELECTRONIC COMPUTERS AND THEIR BUSINESS APPLICATIONS

A. J. BURTON and R. G. MILLS

ERNEST BENN. 1960. 325 PP. £2 5S.

IT is now well established that a computer for business purposes should be designed quite differently from one suitable for scientific calculations, especially with respect to the input and output devices. It is also realized that the programming is quite different, since for business applications a great deal of thought has to be given to the preparation of suitable editing for the format of the output.

The authors postulate a computer CASSEAC, which has the features desirable for a business computer. They discuss briefly and clearly the aspects of the preliminary survey into a business application and the staff required, and programming rather more fully.

The second half of the book describes applications in payroll, sales accounting and stock control, banking and insurance. A set of photographs of peripheral equipment is included, and should be a help to non-technical readers to see what is involved in a proposed installation.

The volume is recommended as very useful to people who are concerned with the planning and programming of a computer for business use. A. T. STARR

ELSEVIER'S DICTIONARY OF AMPLIFICATION, MODULATION, RECEPTION AND TRANSMISSION

W. E. CLASON (*Editor*)

AMSTERDAM: ELSEVIER. LONDON: VAN NOSTRAND. 1960. 804 PP. £6

THIS dictionary gives the translation of 2924 English technical terms into French, Spanish, Italian, Dutch and German. The entries are arranged in alphabetical order of the English terms, each entry being assigned a number. The entries are in rows, across a double page, so that each one reads as follows: reference number, English term, subject, English definition, French etc. terms, reference number repeated.

In thumb-marked sections, the French speaker, say, is given an alphabetical list of the French terms with their reference numbers so that he can easily locate the required phrase. For example, he looks up 'amortissement critique', to find it is no. 552. No. 552 in the body of the text gives the English 'critical damping', German 'kritische Dämpfung', etc.

If he is stupid enough to look up 'radar', he finds it is no. 1977 and is translated 'radar' in all five other languages, the Germans having the alternative 'Funkortung' (fem.) into the bargain. Funnily enough, there is no cross-reference to 'radiolocation'. In general, there is too much of this sort of thing, which might be tolerable in a normal dictionary but is surely out of place in technical translation.

It is, of course, very easy to fault a book of this type, especially when it is the work of a single individual, and I should emphasize that most of the terms included are succinctly defined, usually correctly, and are reasonably translated. The coverage is, however, capricious: for example, the terms 'double-stream amplifier' and 'velocity-modulation

amplifier' are included but 'travelling-wave amplifier' is not.

The volume will be of value in literal translation for patent and legal purposes and to professional translators. The average engineer will require more bits (not included) per pound.

A. H. W. BECK

STATISTICAL THEORY OF SIGNAL DETECTION

C. W. HELSTROM

LONDON: PERGAMON PRESS. 1960. 364 PP. £3 3S.

THIS is a mathematical approach to detection, in the presence of random noise, of electrical signals such as those used in radar and communication. The author states that he has tried to make his treatment of the subject useful to both the mathematician and the engineer, and he has succeeded in steering this middle course with considerable success.

After an introduction to the theories of linear filtering and random noise, there follows a description of the statistical theory of hypothesis testing. Signal detection is then treated as a decision problem to provide a basis for the design of detection systems. The performance of these systems is analysed in terms of false-alarm and detection probabilities. Finally, the estimation of signal parameters in the presence of random noise and the resolution of overlapping signals are considered.

The material is clearly presented, and the book should be found useful by engineers having design problems in the field covered and by theoretically minded students interested in the application of decision theory to problems in signal detection. An excellent and extensive bibliography is provided.

J. A. SAXTON

MANAGEMENT SURVEY

F. HOOPER

PENGUIN. 1960. 218 PP. 3S. 6D.

SIR Frederick Hooper's interest and activities in business training and his practical experience in application are sufficient recommendation for this book to anyone approaching the art and science of management for the first time. Written in conversational style, it covers a vast amount of ground without going into too great detail.

It was written in 1948, and the present edition varies from that only by the addition of a number of footnotes. It speaks highly for its contents that, 12 years later, it deals with almost every type of problem with which management is faced today. Perhaps the most interesting chapters are those dealing with lines of communication in a modern business, the selection and training of personnel whether recruited internally or externally, and the evils of overcentralization.

As a point of criticism, engineers reading the text may well feel that Sir Frederick has underemphasized the need in highly technical businesses for management trainees to receive a preliminary training on the shop floor and in the offices.

The new edition comes at an opportune juncture, coinciding with the report of the working party set up by the Ministry of Education to advise on college courses in management studies, and at a time when there may be some hope of introducing postgraduate courses into the curricula of some of our universities.

C. DANNATT

PRINCIPLES OF SEMICONDUCTOR DEVICE OPERATION

A. K. JONSCHER

LONDON: BELL. 1960. 168 PP. 30S.

THE author sets out to bridge the gap between, on the one hand, the large amount of published material on the properties and behaviour of semiconductors and, on the other, the even larger amount of material on circuit applications of transistors.

He first briefly outlines basic semiconductor theory, and goes on to consider non-equilibrium carrier densities and the transport of excess carrier densities. This leads to the study of *p–n* junctions and then of multi-junction structures (the conventional transistor is dealt with in 13 pages). The final chapter is on 'Carrier flow in inhomogeneous media', and there are some useful appendixes. The treatment is in general clear and concise, mathematics being sparingly but effectively used. Discussion of transistor small-signal parameters and equivalent circuits has (mercifully) been restricted to three pages; but, when considering the large-signal behaviour of transistors, the author has missed a clear opportunity to link up with the widely used Ebers and Moll equations.

It is a pity that there is no mention of the tunnel diode (Esaki's paper is included in the bibliography). Another omission is noise in semiconductor devices, which might have been fitted quite well into the text.

The book nevertheless contains a great deal of valuable information, well presented, which should enable users of semiconductor devices to gain a more nearly complete understanding of the behaviour, limitations and possibilities of these devices.

E. H. COOKE-YARBOROUGH

TOWARDS A UNIFIED COSMOLOGY

R. O. KAPP

HUTCHINSON. 1960. 303 PP. 35S.

'LUNIKS' hit the headlines; 'Space' takes space in our modern daily Press. But what do we know about the cosmos? Physicists believe that when they find the links between electromagnetic, nuclear and gravitational fields they will learn the 'secret of the universe'. Einstein and de Broglie long sought that unitary equation that would explain its origin and laws.

When (or if?) such an equation is found, it will have to be explained. Prof. Kapp's book may contain the essentials of a step forward towards the goal of a unified cosmology. The author is an electrical engineer of high repute, formerly an academic, now a consultant. His work in several fields, not excluding the humanistic, has gained for him a warm respect. A reader must therefore take seriously some rather startling ideas.

The ground is prepared by an appeal to the philosophical Principle of Minimum Assumption as the most basic in

physics because it precludes every *ad hoc* explanatory hypothesis of a specific kind. The hypothesis of the Symmetrical Impermanence of Matter is, says the author, in agreement with the Principle because it can explain so much without further assumption.

This hypothesis is that matter can originate or become extinct at any place and at any time. With it the origin and evolution of galaxies and, in particular, the phenomenon of gravitation can be explained. Gravitation is a quantum phenomenon, says Prof. Kapp: a particle does not carry a gravitational field around with it, and the gradient occurs only as a consequence of the extinction of the particle. An extinction generates a gravitational pulse.

Properly to weigh the arguments, the reader must be a competent cosmologist already. Nevertheless, the engineer layman can gather a great deal from it, for with much of the climate of the discussion he is familiar. The ideas are presented at steady pace, with cogency and clarity yet withal in a manner attractively modest. For this is not a 'crank' book: it is rational and of serious purpose.

In the epilogue the author claims two aspects for reality. One is the rough, untouched world of lifeless things; the other is non-material. The division is compelling, for no purely materialistic philosophy could explain the rich personality that comes through the author's words.

M. G. SAY

THE ARC DISCHARGE

H. de B. KNIGHT

CHAPMAN AND HALL. 1960. 444 PP. £3 3S.

WRITTEN by an author well known for his contributions to the field, this work gives a very complete account of the application of gas-discharge valves to the control of electrical power. It is complete in that it covers the physical processes occurring in the valves, associated circuitry, specification, operation, and maintenance. It is thus of equal interest to the user of these devices in normal circumstances, and to research and development engineers who find themselves confronted by a novel application.

It is written throughout in a clear and concise style which it is a pleasure to read, and is well illustrated. A welcome feature is the manner in which the physical characteristics are explained as an aid to the better understanding of applications and ratings. Containing useful appendixes on fields of force and the properties of gases, the book is equally suitable for first study and for revision.

The text is arranged in three parts. The first gives introductory material on the principles of operation, characteristics, and construction of the various types of valve. Part 2 is devoted to physical processes in the discharge, including emission, ionization, electrical-discharge mechanisms, space charge, and associated phenomena. Here, the section on stages in the development of the discharge and the composite diagram of Fig. 4.15 will be of special interest to new readers in this much discussed subject.

The third part, headed 'The valve in use', is self-explanatory in title, contains 174 pages of information on circuits, ratings, and operation, and is a mine of information to the user.

This is a volume which is likely to command the wide circulation that its merits deserve.

STRUCTURE AND PROPERTIES OF THIN FILMS

C. A. NEUGEBAUER, J. B. NEWKIRK and D. A. VERMILYEA (*Editors*)

NEW YORK: JOHN WILEY. LONDON: CHAPMAN AND HALL. 1959. 561 PP. £6

THIS collection consists of 42 papers (with discussion) presented at an international conference at Bolton Landing, New York, in September 1959.

An increasing amount of research is being devoted to the study of thin films, which is partly due to the technical applications of thin films in interference filters, resistors, capacitors, photocells and magnetic memory elements for computers; in particular, in today's efforts in microminiaturization of electronic circuits, film techniques are of great importance.

However, the greater part of the study of films is being undertaken on a purely fundamental basis, and it was from this aspect that the conference approached the subject. Many features of the solid state can best be studied by the observation of the formation and properties of thin films whose structure can be readily controlled by varying the temperature of the substrate onto which the film is deposited.

The present text is divided into five main sections: the formation of thin films, their mechanical, electrical and magnetic properties, and the chemical interactions on surfaces. Each section is introduced by a fairly comprehensive review, contributed by recognized authorities in the field; these review articles will be of great value to the general reader.

As a result of using a photo-offset process, the book has been published extremely quickly, and the editors and publishers must be congratulated on making available to the general public the proceedings of this apparently very successful conference in record time. A penalty to be paid for this is the large size and heavy weight of the volume.

P. POPPER

AUTHORITY, RESPONSIBILITY AND EDUCATION

R. S. PETERS

ALLEN AND UNWIN. 1959. 137 PP. 12S. 6D.

THIS is a collection of eight B.B.C. talks and two lectures to teachers on broad educational topics. Their common thread of argument seems to be that the present era is one in which rules for living, established by the authority of fathers, society and the Churches, are ceasing to be accepted automatically, and this places on the shoulders of the young individual the task of making his own moral judgments.

Mr. Peters then suggests that the doctrine of determinism makes this more difficult; for, if people believe that what they do is determined by social causes or early emotional experiences, they are less likely to grapple with the problems of living creatively and intelligently. In a final section on the philosophy of education, the conclusion is reached that

education should cultivate the spontaneous, value-creating potentialities of men and women, and not be confined to training to obey rules and to accept authority.

This is all sweetly reasonable and not at all new. The only harm it might do in a teacher's training college would be to convey the impression that the matter is very simple, and that all we have to do is to use our intellects vigorously and individually, and then moral problems will present no difficulty. Although Mr. Peters does not resolve the difficulties, both philosophical and practical, of his thesis, we may be grateful for his main conclusion, which seems to be that there are unexplored possibilities in education for cultivating the sensibility of future generations to humane values.

As a liberal idealist, he wants very much to believe that man is indeed higher than the animals, and that morality can be equated with reasonableness. But a commonplace of the modern view is that no purpose can be validated wholly within the field of reason, however relevant it may be that values and purposes should be formed in the light of reason. Although he has obviously read widely in psychology, he seems to be but dimly aware of the volcanic nature of the forces below the crust of social order.

His attitude to science is unclear. He seems to share the familiar view that training in a scientific field, provided that it involves inspiration from the right kind of teacher, and is not authoritarian, can result in the capacity to think clearly, and that this will necessarily result in goodness. But he sees clearly enough that scientific findings as such can sometimes make the individual's adjustment to social needs more difficult. He is also well aware that knowledge may be used for evil purposes, and views it with some suspicion. Nevertheless he is essentially an intellectual and thinks that the head can adequately guide the heart.

These essays are well written, pleasant to read, and quite sensible, but they scarcely rise far enough above the level of soothing syrup to be regarded as a significant addition to educational literature.

A. TUSTIN

RADIO AND ELECTRONICS—Vols. 1 and 2

J. H. REYNER (*Editor*)

PITMAN. 1960. 1042 PP. £5 5S. PER SET

THESE volumes contain a collection of 27 articles on various aspects of radio and electronics. According to the editor's foreword, they are intended to provide the student, the craftsman and the younger professional engineer with authoritative information on the fundamental background and principal uses of electronic techniques. Although the articles naturally vary in quality, many of them are written by recognized experts and the general level of presentation is high. The first tome is devoted to mathematics and fundamental principles of electrical engineering, while the second covers more specialized topics and applications.

It is pertinent to inquire whether collections of this nature any longer serve a very useful purpose. In the past, when technical publications were hard to come by, such books have played an honourable part in the education of the young engineer. Times are changing, however, and today the serious student should expect to have access to the literature of his subject—from The Institution, his place of employment, his local public library or his local technical college. Does he then need the comprehensive work which attempts to cover the whole of electronic engineering in two volumes?

It goes without saying that anyone who buys them will find much that can be read with interest and profit; and, at first sight, they represent very good value for money. Further consideration may suggest that no one reader is likely to want all the articles and that some things that he would like are missing. For example, the present reviewer would gladly exchange 66 pages on a.c. and d.c. motors, and generators, and another 17 on primary and secondary cells, for a more detailed account of radar developments since the war (which occupy less than a page) or of computers (which are dismissed in a paragraph). However, these are matters of opinion.

C. W. OATLEY

HOCHSPANNUNGSTECHNIK—4th edition

A. ROTH

VIENNA: SPRINGER-VERLAG. 1959. 756 PP. £14

LEHRBUCH DER HOCHSPANNUNGSTECHNIK

G. LESCH and E. BAUMANN (*Editor*)

BERLIN: SPRINGER-VERLAG. 1959. 444 PP. DM 39.6

IT may be significant that, despite the many texts in the English language on specialized problems in high-voltage engineering, no author has yet attempted to cover this large field in one volume. Yet here are two books, published by two sections of the same publishing house, simply entitled 'High-voltage technique'.

The monumental tome by the Swiss author, A. Roth, is the fourth, greatly extended, edition of a work which, for over 30 years, has been regarded as 'standard' by continental engineers. Written by the head of a large manufacturing undertaking, it will be appreciated both by the designer of high-voltage equipment and by the user. The first half examines the properties of gaseous, solid and liquid insulants and their combinations, including some of the latest synthetic materials. The second half deals with system overvoltages and with equipment for high-voltage a.c. and d.c. networks. The extensive bibliography is slightly marred by lack of care in proof-reading.

The second offering, written by the late Professor of the University of Karlsruhe, will be specially welcomed by the more academically inclined reader, although it will be equally valuable to the practical engineer. The bulk of this publication discusses the application of electric-field theory to the calculation and design of high-voltage equipment and the properties of dielectrics. This is followed by an investigation of system overvoltages. The treatment is largely unreferenced, but the expert reader will be interested in the results of some new research work in the author's department.

Both books contain a wealth of information of immediate practical importance, so that, apart from their tutorial value, they should be welcomed as works of reference by the practical engineer who has no ready access to the more specialized treatises or publications.

R. H. GOLDE

** Denotes that the publication is also in the Lending Library. The publications cannot be bought through The Institution; the publishers and the prices are given only for the convenience of members*

LIBRARY ACCESSIONS

BOOKS

ASHBY, W. R. 621–52

Design for a brain; the origin of adaptive behaviour. **2nd edition revised***

London: Chapman and Hall, 1960. pp. ix, 286. 22 × 14cm. £2 2s.

This book deals with the behaviour of the brain as a mechanism. It has been largely rewritten to take account of the better understanding of the subject which has developed since the previous edition was written.

BIRKS, J. B., and SCHULMAN, J. H. (*Editors*) 537.226

Progress in dielectrics—Vol. 2*

London: Heywood, 1960. pp. vii, 225. 25·5 × 16cm. £2 15s.

This second annual volume in the series deals mainly with dielectric properties in weak electric fields. There are six papers, including an introductory survey of the theory of polarization and absorption in dielectrics, dielectric properties of polymeric systems, dielectric properties of glass, high-permittivity ceramics for capacitors, and artificial dielectrics. This book will be reviewed in a future issue.

BORDEN, P. A., and MAYO-WELLS, W. J. 621.317.083.7

Telemetering systems*

New York: Reinhold. London: Chapman and Hall, 1959. pp. ix, 349. 24 × 15·5cm. £3 8s.

A comprehensive work which describes the various types of telemetering system, including mobile telemetering, and the techniques used rather than the commercial equipment available.

CHACE, W. G., and MOORE, H. K. (*Editors*) 537.529 : 536.4

Exploding wires*

New York: Plenum Press. London: Chapman and Hall, 1959. pp. ii, 373. 24 × 15·5cm. £3 16s.

Twenty-six papers on the phenomena which occur when a wire is explosively vaporized by the sudden passage of a large current. The theory of the subject and applications are dealt with, and oscillographic and photographic investigations are described and illustrated. This book was reviewed in the February 1960 *Journal*, p. 118.

CLASON, W. E. (*Editor*) 413 = 00

Elsevier's dictionary of amplification, modulation, reception and transmission in six languages: English/American/French/Spanish/Italian/Dutch/German

Amsterdam and London: Elsevier, 1960. pp. 803. 23 × 15cm. £6

This book is reviewed on p. 447.

DUDLEY, A. M., and HENDERSON, S. F. 621.313.045

Connecting induction motors; operation and practice. **4th edition**

New York and London: McGraw-Hill, 1960. pp. xv, 425. 24 × 15·5cm. £5 4s. 6d.

The text includes many diagrams and tables whereby windings may be designed or converted. There is a chapter on locating faults in windings.

KIRCHMAYER, L. K. 621.311.003

Economic control of interconnected systems*

New York: John Wiley. London: Chapman and Hall, 1959. pp. ix, 207. 23·5 × 15cm. £5

Deals with the use of mathematical models and computers for obtaining the optimum economic operation of interconnected power systems, including combined steam and hydroelectric systems. This book will be reviewed in a future issue.

KOHL, W. H. 621.385.032

Materials and techniques for electron tubes (revised edition of Materials technology for electron tubes)*

New York: Reinhold. London: Chapman and Hall, 1960. pp. xviii, 638. 23·5 × 15·5cm. £6 12s.

A comprehensive work which deals with the physical characteristics of the materials used in the construction of vacuum tubes and describes some of the processes involved in using these materials.

LAUER, H., and others 621–52

Servomechanism fundamentals. 2nd edition*

New York and London: McGraw-Hill, 1960. pp. xiv, 491. 23·5 × 15·5cm. £3 17s. 6d.

This describes the general principles of control systems and their component parts. The analysis of both linear and non-linear servomechanisms requires mathematical treatment, but the Laplace transformation is not introduced. In the final chapter, examples of design problems are worked out.

MORGAN, J. H. 620.19

Cathodic protection: its theory and practice in the prevention of corrosion*

London: Leonard Hill, 1959. pp. xviii, 325. 25 × 16cm. £2 17s. 6d.

Explains the techniques of cathodic protection and the methods to apply in practice to actual structures. This book is reviewed this month on p. 446.

NEAL, J. P. 621.31

Electrical engineering fundamentals; a unified introduction to electrical engineering

New York and London: McGraw-Hill, 1960. pp. xiv, 402. 24 × 15·5cm. £3 6s.

This is for students and contains many worked examples and questions for the student to solve. The M.K.S. system is used throughout, and a knowledge of calculus is necessary to follow the mathematical treatment.

PLOEG, P. van der 621.385

Industrial electronics apparatus; steps in design and maintenance*

London: Cleaver-Hume Press, 1960. pp. ix, 97. 20·5 × 14·5cm. 9s. 6d.

This thoroughly practical book is unique in that it sets out to show how the trouble-free operation of electronic equipment depends on the little things that matter in design, production and maintenance. It is illustrated by a number of interesting diagrams and photographs as well as the usual circuit diagrams.

REYNER, J. H. (*Editor*) 621.39

Radio and electronics. 2 vols.*

London: Pitman, 1960. Vol. 1, pp. ix, 548. Vol. 2, pp. ix, 494. 25·5 × 19cm. £2 12s. 6d. each vol.

A practical work in which highly theoretical considerations are avoided and basic principles emphasized. Vol. 1 deals with electrical engineering principles generally, engineering mathematics, electronic components and electron tubes and transistors, propagation modulation, and h.f. phenomena and techniques.

Vol. 2 is devoted mainly to practical applications in radio transmission and reception, including marine and aeronautical equipment, navigational aids and radar. Television systems, sound reproduction and other

Library accessions (continued)

applications are also covered. This work is reviewed this month on p. 450.

RIDER, J. F., and USLAN, S. D. 621.317.755

Encyclopedia on cathode-ray oscilloscopes and their uses. 2nd edition

New York: Rider. London: Chapman and Hall, 1959. pp. xix, 1172. 29 × 22·5cm. £10 10s.

Describes the principles of cathode-ray-tube operation, time-bases and measuring techniques; deals with practical applications and commercial equipment; and gives details of tube characteristics. Methods of photographing images are discussed and illustrated.

RODENHUIS, E. 621.395.645

Hi-fi amplifier circuits*

London: Cleaver-Hume Press, 1960. pp. ix, 105. 21 × 15cm. 15s.

This is another in the fast-growing series of Philips Technical Library books which are essentially practical, simple and readable. It is aimed at those who wish to build high-quality reproduction equipment, including pre-amplifiers.

SEITZ, F., and TURNBULL, D. (*Editors*) 539.11

Solid state physics; advances in research and applications. **Vol. 7**

New York: Academic Press Inc., 1958. pp. xiv, 525. 23·5 × 15·5cm. £5

Contains papers on thermal conductivity and lattice vibrational modes, electron energy bands in solids, the elastic constants of crystals, wave-packets and transport of electrons in metals, the study of surfaces by using new tools, and the structure of crystals. This book was reviewed in the April 1960 *Journal*, p. 245.

TYERS, A., and MILES, R. B. 621–52

Principles of servomechanisms*

London: Pitman, 1960. pp. vii, 176. 22 × 14cm. 25s.

A non-mathematical explanation of servomechanism theory for students of intermediate-certificate level in telecommunications. This book will be reviewed in a future issue.

OTHER PUBLICATIONS

POST OFFICE

Safety precautions relating to intense radio-frequency radiation

London: H.M.S.O., 1960. pp. 8. 21 × 13·5cm. 9d.

AUTOMATIC TELEPHONE AND ELECTRIC CO.

B.P.O. no. 706 telephone. Engineering Bulletin 526. Issue 1

London and Liverpool: Automatic Telephone and Electric Co., 1960. pp. 13. 27·5 × 21cm. n.p.

A.T.E. no. 7 telephone. Engineering Bulletin 528. Issue 1

London and Liverpool: Automatic Telephone and Electric Co., 1960. pp. 17. 27·5 × 21cm. n.p.

INSTITUTE OF RADIO ENGINEERS—PROFESSIONAL GROUP ON MEDICAL ELECTRONICS

Bibliography on medical electronics. Supplement 1

New York: I.R.E., 1959. pp. 68. 28 × 21cm. $2.50

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

The automatic telex service by A. E. T. Forster, R. W. Barton and W. A. Ellis. Paper 215

London: Institution of Post Office Electrical Engineers, 1959. pp. 30. 27·5 × 21cm. 2s. 6d.

NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL

Conference on electrical insulation; annual report 1959. Publication 756

Washington, D.C.: National Academy of Sciences—National Research Council, 1960. pp. 153. 27·5 × 21cm. $4.00

SOCIÉTÉ DES RADIOÉLECTRICIENS

Proceedings of the international congress on ultra-high-frequency circuits and antennas, 21st–26th October 1957—Vols. 1 and 2 (*L'Onde Électrique*, 1958, No. 376 bis, supplément spécial)

Paris: Société des Radioélectriciens, 1958. pp. 859. 27 × 21·5cm. £6 7s. 6d.

UNITED NATIONS
ECONOMIC COMMISSION FOR EUROPE

Outlook for nuclear energy as a source of power

Geneva: United Nations, 1959. pp. iii, 39. 28 × 22cm. 2s.

Rural electrification—Vol. 4

Geneva: United Nations, 1959. pp. ii, 145. 28 × 22cm. 9s.

Contents of the current *Proceedings*

The date in italics is that of the Journal review, special article, or synopsis. Where given, the date in capitals is the month in which a paper or monograph was published individually

PART A. POWER ENGINEERING (JUNE 1960)

See the Journal for June 1960, p. 385

PART B. ELECTRONIC AND COMMUNICATION ENGINEERING (JULY 1960)

F. HORNER, M.SC. PAPER 3238E **Design and use of instruments for counting local lightning flashes** *July 1960*

P. VIGOUREUX, D.SC. PAPER 3012M, JULY 1959 **Development of the formulae of electromagnetism in the M.K.S. system** *May 1960*

P. N. BUTCHER, PH.D. PAPER 3220E, FEBRUARY 1960 **Introduction to the theory of solid-state masers** *July 1960*

J. M. FREE, B.SC., *and* G. B. WALKER, PH.D., M.A. PAPER 3223M **Determination of the dielectric properties of low-loss ceramics at Q-band frequencies** *April 1960*

A. A. NEW, M.SC. PAPER 3261M **Some mechanisms of failure of capacitors with mica dielectrics** *May 1960*

A. J. HYMANS, M.SC., *and* J. LAIT, M.A. PAPER 3264E **Analysis of a frequency-modulated continuous-wave ranging system** *May 1960*

F. HORNER, M.SC. PAPER 3267E **Extra-terrestrial radio noise as a source of interference in the frequency range 30–1000 Mc/s** *July 1960*

H. F. CHURCH. PAPER 3277E **Long-term stability of fixed resistors** *July 1960*

Discussion on **Design of an automatic sensitivity control for a new subscriber's telephone set** before the North-Eastern Measurement and Electronics Group

Discussion on **Recognition of moving vehicles by electronic means** before the Northern Ireland Centre

PART C. MONOGRAPHS (MARCH 1960)

See the Journal for March 1960, p. 183

Elections and Transfers

The following elections and transfers approved by the Council are effective from the 23rd June 1960

ELECTIONS : 1st LIST

Graduates

ANDERSON, Charles Albert, B.SC., B.ENG.
BANKS, Trevor, DIP.TECH.(ENG.)
CLARKE, Robin, B.A.
CUMMINGS, Leonard, B.SC.
DESMARES, Ian Richard
DIXON, George Gibson, B.SC.
FRECK, David Vernon, B.SC.
HENRY, Timothy Arthur, B.A.
HUGHES, John
KHAN, Fida Mohammed
MACHEN, Peter Christopher, B.A.
NEWCOMB, David Arnold, B.E.
NEWEY, Brian John
OLLIN, Wynford
PATLA, Nagendranath, M.SC.
PETHERAM, Roger Herbert
PLEVEY, Geoffrey William
REES, Gwilym
ROBERTS, William Elwyn, B.SC.
SCHRODER, Frank, B.E.
SHARP, Edward Brian, D.L.C.
SHERRINGTON, John Alexandre, B.SC.
SIMPSON, Dennis George
SMITH, George Mitchell, B.SC.
TAVENER, Michael Alfred, B.A.
WELLS, David Walter, B.SC.(ENG.)

Students

AGRAWAL, Narendra Kumar
ALLAN, Alexander Robert, B.SC.
ARCHBOLD, Derrick
AUBREY, David Richard
BENNETT, Melville Valentine
BLACKWELL, John Edward
BOWERN, Michael Edward
BRISTOW, Edward
BROMILEY John Charles
BROWN, Stewart Duff
CAVEY, Eric Terence
COATES, Grahame
COOLE, Campbell Fullerton
COWBURN, George
DARZI, Eliezer
DAWSON, Bernard Peter Desmond
EMMERSON, Alan David
EVENETT, Michael Lenton
FRIEND, Beverley William
GARWOOD, Robert Henry
GRANT, Cameron John
HAWKESWOOD, Stanley Harold
HOLE, Digby Thomas
HOOD, Thomas John
HOOK, Derek John
HOPKINS, Laurence Neil
HORNE, Peter John
HUGHES, John William
HUNTER, John Roger
HUNTER, Magnus Cluness
IRONS, Roger Geoffrey
JENKINS, Ernest Gwyn
JEPHTHA, Anthony
JOHNSTON, Edward
KENDALL, John Michael
KENYON, Richard Arthur
KNOX, Andrew Barrie
LEACH, Gerald Edward
LUK, Woon Kwan
McBRIDE, Edwin John
McKELLAR, Ian Dugald
MALLAWARACHCHI, Don Godfrey
MARSH, Colin
MORLEY, Robert Matthew Cyril
MUIR, Neville Patrick
MUNRO, Ian Campbell
MURDOCH, Alexander Thomas
MUZUMDAR, Shashikant Sadanand, B.TECH.
ONSLOW, David John
ORCHARD, Brian Bertram Charles
PEARCE, Christopher Thomas
PICKERING, John Adrian
PLAUTUS, Jack
ROBERTS, David Christopher
ROBINSON, Alan Arthur
ROBINSON, James Trevor
RUSH, David, B.SC.
SMEATON, Hugh
SMITH, Colin
SPEEDY, John Peter
STEWART, Peter Grassick
STOKES, Wilfred Trevor
SUGDEN, George Barry
THACKERAY, Christopher Hartley
TOOVEY, Alan Ronald
WARNER, Eric Gordon
WATSON, Alexander Stewart Black
WHITWARD, William Arthur
WILKINSON, John Donald
WILLIAMSON, James McDonald
WOHLGEMUTH, Michael David

TRANSFERS: 1st LIST

Student to Graduate

BOSE, Buddha Dev, B.SC.
BROWN, Reginald William Viney, B.SC.(ENG.)
BURTON, Christopher Philip, B.SC.
CUTTRISS, Henry Noel, B.E.
DALY, Peter, B.SC.
DELLOW, John Brian, B.SC.(ENG.)
DE NORDWALL, Anthony Simon, B.SC.(ENG.)
FALLSIDE, Frank, B.SC., PH.D., M.A.
FORD, Rex Kenneth John, M.SC.
HUGHES, David Edward, B.SC.(ENG.)
JONES, Daniel Orbryn, B.SC.
KEENAN, Campbell Houston, B.E., B.SC.
NASSER, Costandi Nasri, B.SC.(ENG.)
POSHYANANDA, Somvonk
WILSON, Michael Gage Farlow, B.SC.(ENG.), PH.D.

ELECTIONS: 2nd LIST

Graduates

AMOS, Henry James
BIDEN, Neville Douglas
CAMPBELL, Donald Gordon, B.A.
CASHMORE, Brian Howe, B.SC.(ENG.)
GRAFF, David Maurice, B.SC.(ENG.)
HEAD, Derick Harry
SMIT, Arthur Sidney, B.SC.(ENG.)

Students

BOWEN, Alan William
BOYLETT, John Edward

Students (continued)

BRAY, Peter William Linzee
CHRISTMAS, Colin
FITTON, Dennis
GOLDSMITH, Edward Martin
LOWE, Jeffery Ronald
PASSMORE, Cyril David
ROBINSON, James McCawley
RYAN, Anthony Geoffrey
SHAKESPEARE, David William
TOTHILL, Hugh Alfred William
WOODS, John Henry

TRANSFERS: 2nd LIST

Student to Graduate

DOBBIN, William Charles Henry, B.SC.
EVANS, Michael Gareth Kiloh, B.SC.(ENG.)
GENT, Sub-Lt. Colin Michael, B.SC.(ENG.), R.N.
HARRIS, Keith Dillon, B.SC.
LEWIS, William David, B.SC.TECH.
PARTRIDGE, Stephen John, DIP.TECH.(ENG.)
VICKERS, John Edward, B.SC.
WING, Graham Robert, B.SC.(ENG.)

The following elections and transfers approved by the Council are effective from the 1st July 1960

ELECTIONS

Associate Members

BARRON, Oliver Harold, B.SC.
CAMM, Norman
DILGER, Laurence, B.SC.
EYAL, Joseph
FAHMY, Fawzy Abdel Latif
FORD, John Robert
ISTED, Gerald Arthur
PURDON, Marcus Chrispin, M.A.
ROBINSON, William Gaythwaite Harcourt, B.A., B.SC.
ROWE, Bernard Edwin, B.SC.
SAINT, Ernest William
SHENG, Ching Lai, B.SC., PH.D.
SNELSON, Thomas Heald
TAYLOR, Ian Douglas Niven, M.SC.TECH.
WEBBER, Capt. Harold Roger, R.N.
WELLS, Arthur Lewis, B.SC.(ENG.)
WILLIAMSON, Arthur Edward, B.E.

Associates

JENNER, Cmdr. Percy John, R.N.
WARBURTON, Peter John Henry

TRANSFERS

Associate Member to Member

BAKER, Claude Frederick George, D.F.H.
BYRON, Frederick Augustus William, O.B.E.
DOSSOR, Capt. Frederick, C.B.E., B.SC.(ENG.), R.N.
FLOYD, Cyril Farvis, M.A.
GARRY, Capt. Francis Keith, B.E., R.E.M.E.
GRIFFIN, Percy Alexander, B.E.
HAMILTON, Ralph Frederic Gilbert, B.SC.(ENG.)
HARTLEY, Kenneth A., B.SC.TECH.
JACKSON, Gerald Breck, D.F.H.
LEATHLEAN, Stanley William Bawden, M.SC.(ENG.)
OSWALD, Joseph William, B.SC.
PAYNE, Edwin Malcolm
RIDLEY, John Wallace, M.A., B.E., B.SC.
ROMMEL, Frederick Emil, DIPL.-ING.
ROSTON, Benjamin, PH.D., B.SC.(ENG.)
SPRINGER, Horace Albert
THIRTLE, Arthur Charles

Associate to Member

BENNETT, James

Graduate to Associate Member

ABEL, Eric David
AZULAY, Mordecai, B.SC.(ENG.)
BALCOMBE, Jack
BASS, Weston Stuart, B.SC.(ENG.)
BROWN, George
CARTLEDGE, Derek
CLARK, Timothy James, B.SC.
CLEMENTS, William Edgar, B.SC.
CLIBBON, Michael Edward, B.SC.(ENG.)
COOMBS, John Derek
DARBY, Robert Hartley, B.SC.(ENG.)
DE SILVA, Laddusinhabadu William, B.SC.(ENG.)
ELIAS, Owen Willoughby
FLETCHER, James William
GANGULY, Rabindra Nath Gangopadhyaya, B.E.
GERMAN, Derek Morgan, B.SC.TECH.
GORE, Donald Charles, B.SC.(ENG.)
GREATOREX, Gordon Victor
HALLIDAY, Clyde Muir
HANLON, Keith George
HARRIS, John Percival
HERMAN, Harold
HIBBERT, Donald
HILLIARD, Alfred Joseph
HUTCHESON, David John, B.SC.(ENG.)
HUTCHINGS, Gerald Richard
JUDELMAN, Lazar, B.SC.(ENG.)
McGENNIS, Edward Anthony, B.E., B.SC.
NKELE, Aluma
OLDBURY, Derek James, D.F.H.
PADDON, Dennis William
REED, John Willis
SANDBANK, Carl Peter, B.SC.
SANDELS, Ernest George
SILCOX, Andre Raymond
STOCKING, Donald Thomas
TOLLEY, Brian Hughson, B.SC.(ENG.)
TOWLER, Stanley
WARD, Henry Louis
WATERER, Yearly Joseph
WATSON, Percy
WEIR, Sheila McLeod, B.SC.
WOOD, Kenneth Ettery, B.SC.

ANNOUNCEMENTS TO MEMBERS

THE HOMES FUND

SUMMARY OF CONTRIBUTIONS RECEIVED TO 9TH JUNE 1960

	No. of contributors	£	*s.*	*d.*
£1000 and over	8	8685	0	0
£100 to <£1000	32	7181	3	0
£5 to <£100	916	9560	9	3
£2 to <£5	2268	6242	16	7
under £2	28915	15138	17	8
		46808	6	6

HONOURS AND DISTINCTIONS CONFERRED ON MEMBERS

THE names of these members of The Institution were included in the list of Birthday Honours and Distinctions conferred by Her Majesty the Queen:

PRIVY COUNCILLOR

Erroll, F. J., M.A., M.P. (*Member*)

KNIGHT

McFadzean, W. H. (*Companion*)

KNIGHT COMMANDER OF THE MOST EXCELLENT ORDER OF THE BRITISH EMPIRE

King, C. R., C.B.E. (*Companion*)

COMPANION OF THE MOST HONOURABLE ORDER OF THE BATH

McPetrie, J. S., PH.D., D.SC. (*Member*)

COMMANDER OF THE MOST EXCELLENT ORDER OF THE BRITISH EMPIRE

Allibone, T. E., D.SC., PH.D., F.R.S. (*Member*)
Smith, R. A., M.A., PH.D. (*Associate Member*)

OFFICER OF THE MOST EXCELLENT ORDER OF THE BRITISH EMPIRE

Bennett, V. G., B.SC.(ENG.) (*Associate Member*)
Broadway, R. F., B.SC., PH.D. (*Associate Member*)
Clayton, R. J., M.A. (*Member*)
Cullen, Prof. A. L., PH.D., B.SC.(ENG.) (*Member*)
Merriman, J. H. H., M.SC. (*Member*)
Summer, J. H., M.SC.TECH. (*Member*)
Taylor, F. J. D., M.B.E., B.SC.(ENG.) (*Member*)

MEMBER OF THE MOST EXCELLENT ORDER OF THE BRITISH EMPIRE

McGlashen, R. (*Associate Member*)

ELECTION OF COUNCIL FOR THE YEAR 1960–61

THE following were nominated for the vacancies which will occur in the offices of President, Vice-Presidents, Honorary Treasurer, and Ordinary Members of Council on the 30th September next:

President (a) Sir Hamish D. MacLaren, K.B.E., C.B., D.F.C.*, LL.D., B.SC.

Vice-Presidents (two vacancies)

(a) C. T. Melling, C.B.E., M.SC.TECH., M.I.MECH.E.
(a) B. Donkin, B.A., M.I.C.E.

Honorary Treasurer (a) C. E. Strong, O.B.E., B.A., B.A.I.

Ordinary Members of Council

Members (five vacancies)

(b) F. B. Allcock, B.SC.TECH.
(a) D. A. Barron, M.SC.
(a) F. H. S. Brown, C.B.E., B.SC., M.I.MECH.E.
(a) A. R. Cooper, M.ENG.
(c) J. S. McPetrie, PH.D., D.SC.
(a) Prof. J. M. Meek, D.ENG.
(d) A. R. A. Rendall, O.B.E., PH.D., B.SC.
(e) R. L. Smith-Rose, C.B.E., D.SC., PH.D., F.C.G.I.
(a) H. G. Taylor, D.SC.(ENG.)

Associate Member (one vacancy)

(a) J. C. Arkless, B.SC.
(f) R. Feinberg, DR.-ING., M.SC.

Associate (one vacancy)

(a) J. S. McCulloch

(a) Nominated by the Council

(b) Nominated by W. Ford, B.SC.; J. H. S. Gillingham, B.SC.(ENG.); A. N. Irens; C. J. Manning; A. McL. Mooney, C.B.E.; Prof. G. H. Rawcliffe, M.A., D.SC.; L. A. Sansbury; P. Smith, B.SC.; H. J. Steggall, B.SC.(ENG.); J. D. Stephenson, M.SC., PH.D.

(c) Nominated by J. C. Farmer, B.SC.; S. F. Follett, C.M.G., B.SC.(ENG.); Brig. J. D. Haigh, O.B.E., M.A.; N. E. G. Hill, B.SC.(ENG.); A. M. Pegrum, B.SC.(ENG.); Air Comm. G. H. Randle, B.A., R.A.F.; C. Riley, O.B.E., B.SC.TECH.; T. R. Scott, D.F.C., B.SC.; C. Williams, B.SC.(ENG.); R. C. G. Williams, PH.D., B.SC.(ENG.)

(d) Nominated by A. J. Biggs, PH.D., B.SC.; T. H. Bridgewater; D. C. Espley, O.B.E., D.ENG.; E. W. Hayes; A. W. Montgomery, O.B.E., B.SC.TECH.; E. L. E. Pawley, O.B.E., M.SC.(ENG.); T. Somerville, B.SC.; K. R. Sturley, PH.D., B.SC.; M. van Hasselt; F. Williams

(e) Nominated by Sir Noel Ashbridge, B.SC.(ENG.); W. J. Bray, M.SC.(ENG.); H. Faulkner, C.M.G., B.SC.(ENG.); Brig. Sir Lionel H. Harris, K.B.E., T.D., M.SC., F.C.G.I.; H. G. Hopkins, B.SC., PH.D.; A. B. Howe, O.B.E., M.SC.; J. A. Saxton, D.SC., PH.D.; H. Stanesby; Group-Capt. W. Proctor Wilson, C.B.E., B.SC.(ENG.), R.A.F.V.R.; The Hon. R. T. B. Wynn, C.B.E., M.A.

(f) Nominated by J. Dalton; W. R. Fletcher, B.SC.(ENG.); A. Harmsworth, B.SC.(ENG.); C. Heys; R. M. Johnstone, B.SC.(ENG.); J. Knox, M.SC.; C. N. W. Litting, PH.D., B.SC.; S. D. Mellor, B.ENG.; A. C. Normington, B.SC.(ENG.); J. K. Slack, B.SC.(ENG.)

A ballot has been held, and the result has been reported by the scrutineers appointed at the Ordinary Meeting held on the 28th April 1960.

The constitution of the Council for next session will accordingly be as follows:

President Sir Hamish D. MacLaren, K.B.E., C.B., D.F.C.*, LL.D., B.SC.

The Past-Presidents

Vice-Presidents

B. Donkin, B.A., M.I.C.E.
O. W. Humphreys, C.B.E., B.SC.
G. S. C. Lucas, O.B.E.
C. T. Melling, C.B.E., M.SC.TECH., M.I.MECH.E.
A. H. Mumford, O.B.E., B.SC.(ENG.)

Honorary Treasurer

C. E. Strong, O.B.E., B.A., B.A.I.

Ordinary Members of Council

Members

Prof. H. E. M. Barlow, PH.D., B.SC.(ENG.)
D. A. Barron, M.SC.
C. O. Boyse, B.SC.(ENG.)
F. H. S. Brown, C.B.E., B.SC., M.I.MECH.E.
Prof. M. W. Humphrey Davies, M.SC.
L. Drucquer
J. M. Ferguson, B.SC.(ENG.)
R. J. Halsey, C.M.G., B.SC.(ENG.), F.C.G.I.
Prof. J. M. Meek, D.ENG.
The Hon. H. G. Nelson, M.A.
H. V. Pugh
J. R. Rylands, M.SC., M.I.MECH.E., J.P.
R. L. Smith-Rose, C.B.E., D.SC., PH.D., F.C.G.I.
G. A. V. Sowter, PH.D., B.SC.(ENG.)
H. G. Taylor, D.SC.(ENG.)

Associate Members

J. C. Arkless, B.SC.
D. C. Flack, B.SC.(ENG.), PH.D.
R. A. Hore, M.A., B.SC., WH.SC.
D. H. Tompsett, B.SC.(ENG.)

Companion

Sir John Dean, B.SC.

Associate

J. S. McCulloch

Chairmen and Past-Chairmen of Sections

J. M. Ferguson, B.SC.(ENG.) (Utilization)
C. G. Garton (Measurement and Control)
*T. E. Houghton, M.ENG. (Utilization)
*J. R. Mortlock, PH.D., B.SC.(ENG.) (Supply)
*M. J. L. Pulling, C.B.E., M.A. (Electronics and Communications)
J. E. L. Robinson, M.SC. (Supply)
T. B. D. Terroni, B.SC. (Electronics and Communications)
*Prof. A. Tustin, M.SC. (Measurement and Control)

Chairmen and Past-Chairmen of Local Centres

*J. A. Aked, M.B.E. (Scottish)
R. B. Anderson (Scottish)
*Prof. G. W. Carter, M.A. (North Midland)
*T. A. P. Colledge, B.SC.(ENG.) (Mersey and North Wales)
F. W. Fletcher (North Midland)
Lt.-Col. W. E. Gill, T.D. (East Midland)
R. Goford (Southern)
*F. J. Hutchinson, M.ENG. (North-Western)
J. McA. Irons (Northern Ireland)
*H. Jackson, B.SC.(ENG.) (Western)
Brig. F. Jones, C.B.E., M.SC. (South Midland)
F. Linley (North-Western)
*W. D. Mallinson, B.SC.(ENG.) (Southern)
*D. H. Parry, B.SC. (East Midland)
*G. F. Peirson (South Midland)
D. A. Picken (Mersey and North Wales)
A. C. Thirtle (Western)
D. H. Thomas, M.SC.TECH., B.SC.(ENG.) (North-Eastern)
*H. Watson-Jones, M.ENG. (North-Eastern)
*T. S. Wylie (Northern Ireland)

* Past-Chairmen

ELECTION OF SECTION COMMITTEES FOR THE YEAR 1960–61

ELECTRONICS AND COMMUNICATIONS SECTION

THE following were nominated for the vacancies which will occur on the Committee of the Electronics and Communications Section on the 30th September next:

Chairman T. B. D. Terroni, B.SC.

Vice-Chairman R. J. Halsey, C.M.G., B.SC.(ENG.), F.C.G.I.

Ordinary Members of Committee (six vacancies)

(a) W. H. Aldous, B.SC., D.I.C.
(b) E. M. Hickin
(a) W. J. Perkins
(a) K. F. Sander, M.A., PH.D., B.SC.
(a) J. A. Saxton, D.SC., PH.D., A.R.C.S.
(a) T. R. Scott, D.F.C., B.SC.
(a) F. J. D. Taylor, M.B.E., B.SC.(ENG.)

(a) Nominated by the Section Committee
(b) Nominated by P. S. Carnt, B.SC.(ENG.); F. J. Fisher, M.A., M.SC.; G. F. Small, B.SC.(ENG.); E. R. Thomas, B.SC.(ENG.); W. E. Willshaw, M.B.E., M.SC.TECH.

A ballot has been held, and the result has been reported by the scrutineers appointed at the Section Meeting held on the 27th April 1960. The constitution of the Committee for next session will accordingly be as follows:

Chairman T. B. D. Terroni, B.SC.

Vice-Chairmen

R. J. Halsey, C.M.G., B.SC.(ENG.), F.C.G.I.
J. A. Ratcliffe, C.B.E., M.A., F.R.S.

Past-Chairmen

G. Millington, M.A., B.SC.
M. J. L. Pulling, C.B.E., M.A.

Ordinary Members of Committee

W. H. Aldous, B.SC., D.I.C.
D. A. Barron, M.SC.
P. A. T. Bevan, C.B.E., B.SC.
J. Brown, M.A., PH.D.
G. G. Gouriet
C. G. Mayer, O.B.E.
J. Moir
L. J. I. Nickels, B.SC.(ENG.)
W. J. Perkins
N. C. Rolfe, B.SC.(ENG.)

E. and C. Committee (continued)

K. F. Sander, M.A., PH.D., B.SC.
F. J. D. Taylor, M.B.E., B.SC.(ENG.)
J. A. Saxton, D.SC., PH.D., A.R.C.S.
C. Williams, B.SC.(ENG.)
R. C. Winton, B.SC.
T. R. Scott, D.F.C., B.SC.
A. J. Young, B.SC.(ENG.)

Co-opted Member E. H. Cooke-Yarborough, M.A.

Together with the following:

The President
A Representative of the Council
The Chairman of the Papers Committee
A Representative of each local Electronics and Communications Group
A Representative of each of the three Fighting Services

MEASUREMENT AND CONTROL SECTION

The following were nominated for the vacancies which will occur on the Committee of the Measurement and Control Section on the 30th September next:

Chairman C. G. Garton

Vice-Chairman A. J. Maddock, D.SC.

Ordinary Members of Committee

S. S. Carlisle, M.SC.
W. J. Jefferson
C. A. Laws
F. C. Widdis, B.SC.(ENG.), PH.D.

No other nominations having been received, the constitution of the Committee for next session will be as follows:

Chairman C. G. Garton

Vice-Chairmen

W. S. Elliott, M.A.
A. J. Maddock, D.SC.

Past-Chairmen

Prof. A. Tustin, M.SC.
J. K. Webb, M.SC.(ENG.), B.SC.TECH.

Ordinary Members of Committee

S. S. Carlisle, M.SC.
W. J. Jefferson
C. A. Laws
A. C. Lynch, M.A., B.SC.
R. E. Martin
A. Nemet, DR.SC.TECHN.
S. N. Pocock
W. Renwick, M.A., B.SC.
G. F. Tagg, B.SC.(ENG.), PH.D.
R. D. Trotter, B.SC.(ENG.)
J. H. Westcott, B.SC.(ENG.), PH.D.
F. C. Widdis, B.SC.(ENG.), PH.D.

Together with the following:

The President
A Representative of the Council
The Chairman of the Papers Committee
A Representative of each local Measurement and Control Group
A Representative of the National Physical Laboratory

SUPPLY SECTION

The following were nominated for the vacancies which will occur on the Committee of the Supply Section on the 30th September next:

Chairman J. E. L. Robinson, M.SC.

Vice-Chairmen

C. H. Flurscheim, B.A.
J. S. Forrest, D.SC., M.A.

Ordinary Members of Committee

E. S. Booth, M.ENG.
Prof. M. W. Humphrey Davies, M.SC.
N. G. Simpson
F. C. Walmsley

No other nominations having been received, the constitution of the Committee for next session will be as follows:

Chairman J. E. L. Robinson, M.SC.

Vice-Chairmen

C. H. Flurscheim, B.A.
J. S. Forrest, D.SC., M.A.
D. B. Irving, B.SC.

Past-Chairmen

J. R. Mortlock, PH.D., B.SC.(ENG.)
D. P. Sayers, B.SC.

Ordinary Members of Committee

E. S. Booth, M.ENG.
G. S. Buckingham, B.SC.(ENG.)
W. J. Carfrae, B.SC.
Prof. M. W. Humphrey Davies, M.SC.
J. L. Egginton, B.SC.
C. J. O. Garrard, M.SC.
W. D. Horsley
D. McDonald, B.SC.
O. W. Minshull, B.SC.
N. G. Simpson
F. C. Walmsley
T. W. Wilcox

Together with the following:

The President
A Representative of the Council
The Chairman of the Papers Committee
A Representative of each local Supply Group

UTILIZATION SECTION

The following were nominated for the vacancies which will occur on the Committee of the Utilization Section on the 30th September next:

Chairman J. M. Ferguson, B.SC.(ENG.)

Vice-Chairman W. G. Thompson, PH.D., B.SC.

Ordinary Members of Committee

J. E. Boul, A.C.G.I.
A. V. Lawry
P. M. Martin, B.SC.
A. V. Milton
Prof. G. H. Rawcliffe, M.A., D.SC.

No other nominations having been received, the constitution of the Committee for next session will be as follows:

Chairman J. M. Ferguson, B.SC.(ENG.)

Vice-Chairmen

H. G. Taylor, D.SC.(ENG.)
W. G. Thompson, PH.D., B.SC.

Past-Chairmen

T. E. Houghton, M.ENG.
R. A. Marryat, B.SC.(ENG.)

Ordinary Members of Committee

J. R. Anderson, T.D., B.SC.(ENG.)
S. L. M. Barlow
J. W. Binns
J. E. Boul, A.C.G.I.
J. A. Broughall, B.SC.(ENG.)
C. M. Cock
O. T. Evans
A. V. Lawry
P. M. Martin, B.SC.

A. V. Milton
Prof. G. H. Rawcliffe, M.A., D.SC.
R. F. Richardson, M.B.E.
J. Tozer
C. D. Wilkinson

Together with the following:

The President
A Representative of the Council
The Chairman of the Papers Committee
A Representative of each local Utilization Group
Nominees of the Admiralty, the Air Ministry, the Ministry of Labour and National Service (Factory Department), the Ministry of Works and the War Office

APPOINTMENTS AND NOMINATIONS

WIRING REGULATIONS COMMITTEE SUB-COMMITTEE NO. 7—CARAVAN INSTALLATIONS

ON the nomination of the Electricity Council, the Council have appointed Mr. J. Dunwoody, ASSOCIATE, to succeed Mr. J. F. Smith, B.SC.(ENG.), MEMBER, on the above committee.

COMMITTEE ON RADIO EQUIPMENT FOR CIVIL AIRCRAFT

On the nomination of the Royal Aeronautical Society, the Council have appointed Mr. G. P. Parker, ASSOCIATE MEMBER, to serve on the above committee.

JOINT COMMITTEE ON THE APPLICATIONS OF ELECTRICITY IN AIRCRAFT

The Council have approved a proposal from the Royal Aeronautical Society that the constitution of the above joint committee be increased by the appointment of Mr. G. A. Whitehead, A.F.R.AE.S., and a nominee of the Royal Navy.

B.S.I. CODES OF PRACTICE COMMITTEE FOR BUILDING (BLCP/–) CODE DRAFTING COMMITTEE BLCP/38—HOT WATER SUPPLY

The Council have nominated Mr. J. I. Bernard, B.SC.TECH., MEMBER, to serve as their representative on the above committee.

NATIONAL SOCIETY FOR CLEAN AIR—YORKSHIRE DIVISIONAL COUNCIL

The Council have nominated Mr. A. J. Coveney, MEMBER, to continue to serve as their representative on the above Council and Mr. W. J. A. Painter, MEMBER, to continue as his deputy.

BRADFORD INSTITUTE OF TECHNOLOGY, GOVERNING BODY

The Council have nominated Mr. A. J. Coveney, MEMBER, to serve as their representative on the above governing body.

BRADFORD TECHNICAL COLLEGE, ELECTRICAL ENGINEERING ADVISORY COMMITTEE

The Council have nominated Mr. J. F. Wilson, ASSOCIATE, to serve as their representative on the above committee.

AIR TRAFFIC CONTROL SYMPOSIUM

THE papers and discussions at the symposium on data handling and display systems for air traffic control will be published in August 1960 in Supplement No. 19 to Part B of the *Proceedings*. This Supplement—with its contents and index pages and in a semi-stiff cover—will be complete in a single issue. The prices (post-free) are 12s. 6d. to members of The Institution and 17s. 6d. to non-members.

Copies may be obtained on application to the Secretary of The Institution.

MEMBERS TRAVELLING TO AND FROM THE UNITED KINGDOM

MEMBERS visiting or taking up residence in the areas of any of the Oversea Branches, Oversea Committees or Joint Groups which are listed on pp. 469 and 470 are invited to apply to the Secretary of The Institution for a letter of introduction to the appropriate Honorary Secretary.

If members coming home from oversea will inform the Secretary of The Institution of their address in this country, even if they do not desire a change of address to be recorded in the Institution Register, arrangements will be made for them to be sent information about the various meetings etc. of The Institution and its local Centres and when occasion arises for them to be put in touch with other members.

The Secretary will be glad if members from oversea who are able to visit the Institution premises will call on him.

COMMUNICATIONS FROM OVERSEA MEMBERS

OVERSEA members are specially invited to submit for publication in the *Proceedings* written communications on papers read before The Institution or published in the *Proceedings* without being read. The contributor's country of residence will be indicated. Brief articles, items of news and photographs intended for the *Journal* will also be welcome.

Copies of all papers which will be read before The Institution are sent to each Oversea Representative of the Council for distribution to members likely to be in a position to submit communications.

BRITISH VISITORS TO THE U.S.S.R.

THE Lending Library Unit of the Department of Scientific and Industrial Research are starting to collect reports on visits made by British technical specialists to the Soviet Union. The intention is that these reports will be made generally available on loan.

The reports contain much information which is of interest to British scientists and engineers, and they supplement the Unit's growing collection of original and translated Russian scientific literature. They are also useful to people planning to visit industrial and research establishments in the Soviet Union, and help the staff of the Unit to deal with the increasing number of technical inquiries on current Russian practice.

For some time the Unit have been encouraging 'potential visitors' to consult them well in advance of their visits so that the Unit can advise the visitors about the literature they ought to read and about the more interesting research establishments and factories they might be able to visit. They ask visitors to deposit copies of any relevant reports they might write with the Department of Scientific and Industrial Research, Lending Library Unit, 20 Chester Terrace, Regent's Park, London N.W.1.

BULLETIN OF THE SECTIONS

SUPPLY

SWEDEN'S 400kV NETWORK

BEFORE a well filled Lecture Theatre at Savoy Place on the 11th May 1960, Mr. G. Jancke, chief engineer, research and development, Swedish State Power Board, gave a most interesting Supply Section Annual Lecture, illustrated with many photographs and diagrams, describing the history and the recent developments of the e.h.v. transmission network in Sweden.

In Sweden, 85% of the available hydroelectric power is in the north and 85% of the population is in the south. In 1946, it was decided to proceed with north-to-south transmission at 400kV, and in 1952 the first line, 600 miles long from Harspränget to Hallsberg, was commissioned. This line transmitted 350MW. Now there are three lines, each taking 650MW. All lines are single-circuit with the conductors arranged horizontally.

Future lines

The supply industry in Sweden is not nationalized, but the State Power Board owns 45% of the total capital, and the balance is in the hands of private companies. The Power Board owns and operates the large hydroelectric stations and the 400kV network. The present national demand is some 6000MW, which is expected to rise in the next 20 years to between 8000 and 10000MW

Possible future steps to meet the growth of load have been considered. D.C. transmission is too expensive to use on a network. 650kV and 500kV a.c. systems are not justified, and the decision has been reached to extend the 400kV system and to increase the transmission-line capacity by using larger conductors.

Future lines will have three conductors per phase and total equivalent copper area of 2in.^{2}, whereas the original lines had two smaller conductors per phase, giving only 1in.^{2} of equivalent copper area. This change, combined with the use of series capacitors and shunt reactors to improve both the stability and transmission capacity of the lines, means that future lines will transmit 1000MW or more, compared with 600MW on the original lines after the initial stability limit of 350MW had been overcome.

The introduction of series capacitors in 1954 has been very successful, no faults having occurred since then. There are 600MVAr of capacitors in unattended substations. They reduce losses by 9MW. Some 1000MVAr of shunt reactors have been connected; and, whereas it was formerly necessary to switch out one 400kV line in light loading conditions, this is no longer necessary.

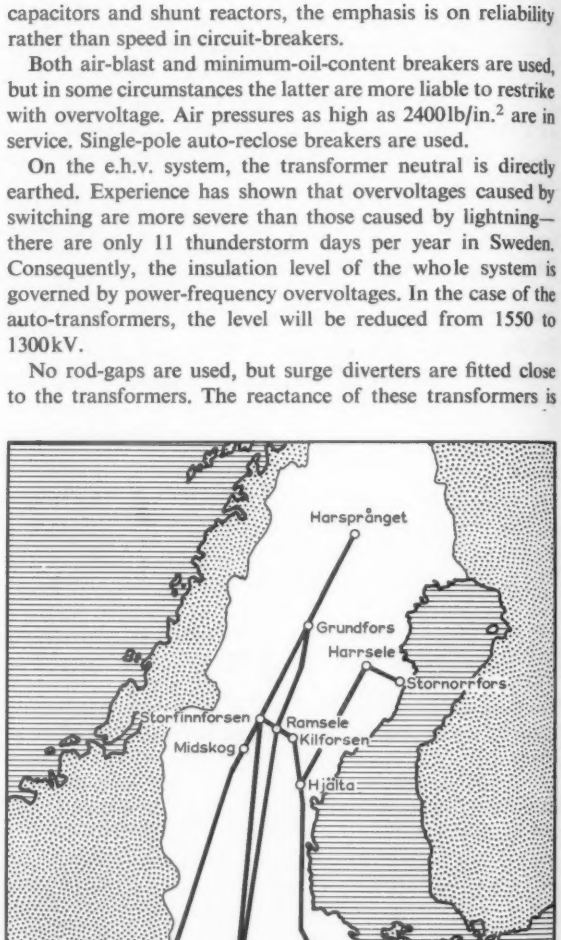
Reliability

In the early days, stability demanded high-speed breakers opening in three cycles; but now, with the addition of series capacitors and shunt reactors, the emphasis is on reliability rather than speed in circuit-breakers.

Both air-blast and minimum-oil-content breakers are used, but in some circumstances the latter are more liable to restrike with overvoltage. Air pressures as high as 2400lb/in.^{2} are in service. Single-pole auto-reclose breakers are used.

On the e.h.v. system, the transformer neutral is directly earthed. Experience has shown that overvoltages caused by switching are more severe than those caused by lightning—there are only 11 thunderstorm days per year in Sweden. Consequently, the insulation level of the whole system is governed by power-frequency overvoltages. In the case of the auto-transformers, the level will be reduced from 1550 to 1300kV.

No rod-gaps are used, but surge diverters are fitted close to the transformers. The reactance of these transformers is



The 400kV network in Sweden

kept low to reduce losses and improve stability. Banks of 3×330 MVA auto-transformers are now being installed.

Earthing is a serious problem in Sweden because of the frequent outcrop of rock, and a continuous counterpoise is used on the lines unless the tower-footing resistance of three or more consecutive towers is less than 30 ohms.

The costs of a breakdown are evaluated in terms of its effect on industry. It was considered that a greater risk could be taken on line insulation than on insulation in substations, because any failure of line insulation could be quickly rectified.

Snow loading

The line insulators are of the cap and pin type, with a grading ring to improve the voltage distribution. Twenty-one $6\frac{1}{4}$ in. units is the maximum length normally employed, but smaller insulators based on a leakage path of $\frac{3}{4}$ in./kV are used in clean atmosphere away from the sea. 1 in./kV is found to be a safe allowance near the coast. Corona losses are 1kW/mile in good conditions, increasing to 5kW/mile as an average.

The lines are built with a normal span of 1100ft, and guyed towers are now used, weighing some 24 tons/mile. Very little mechanical trouble has occurred on the existing lines with bundles of two conductors, but it has been necessary in a few instances to add extra towers to reduce the effects of snow loading.

Warnings of snow loadings on the lines are obtained from the meteorological office; and, as soon as ice or snow loading occurs on lines, gangs are dispatched to places where this is likely to occur and mechanical de-icing is employed. Heating of the conductors on such long lines is impractical.

Little radio interference has been encountered, and there will be even less on the new lines with larger conductors. Measures have to be taken to avoid dangerous induction in telecommunication circuits, which are either fitted with surge arresters or placed underground when in close proximity to the power lines. In the right of way of the lines, all large metal objects are earthed, and no petrol filling stations are permitted.

The Chairman, Dr. J. R. Mortlock, called on Mr. F. J. Lane, who in proposing a vote of thanks to Mr. Jancke, stressed the very helpful co-operation with Sweden which had taken place since the British Supergrid had been initiated. Although the problems here were not identical with those in Sweden, he acknowledged the generous assistance given by the State Power Board.

Prof. M. G. Say supported this with amusing anecdotes concerning the lecturer and sallied into Swedish for his final thanks.

W. J. N.

ELECTRONICS AND COMMUNICATIONS

TRAVELLING-WAVE MASER

At the meeting at Savoy Place on the 7th March 1960, Mr. M. J. L. Pulling being in the Chair, Dr. P. N. Butcher succeeded admirably in the difficult task of giving a clear picture of the physical principles and design features of that elegant form of low-noise amplifier, the travelling-wave maser. His paper is reviewed on p. 441.

This device, which is a negative-resistance amplifier with travelling-wave circuit incorporating non-reciprocal loss, allows stable low-noise amplification with about 20dB gain at frequencies in the neighbourhood of 10^4 Mc/s, with an electronic bandwidth of about a few tenths of one per cent, and tuning range, by magnetic-field variation, of a few per cent. It operates at a temperature of liquid helium (about 4°K) and has an inherent noise factor of less than 0·1dB! The limit to practical noise factor is in fact set by the necessary connection from the input power source, which may be at room temperature, to the amplifier proper.

The active material in this type of amplifier is a special crystal of ruby doped with parametric ions, which when operated in a steady magnetic field may be arranged to act as a negative resistance to microwave magnetic fields, when disturbed from thermal equilibrium by higher-frequency magnetic fields supplied by an r.f. power source, the pump.

Rob the Crown jewels?

After Dr. Butcher had outlined the basic characteristics of the new device, the discussion was opened by Dr. J. C. Walling, who raised questions about the setting up of the circularly polarized magnetic fields necessary for correct operation, and then led on to an invigorating debate, in which several members of the audience joined, on the power-gain formula for a distributed amplifier of this kind.

The question of bandwidth, always in people's minds (even if the noise figure is 0·1dB!), was thoroughly aired; and the author suggested that one way of improving this by a few times was by using a graded magnetic field. He had to confess, however, that he saw no prospect of avoiding the bandwidth limit set by the material itself.

Matters of optimum crystal orientation, factors affecting noise and the possibility of establishing some form of figure of merit for an amplifier of this sort were discussed in turn. Applications so far, it appeared, had been largely in looking at bodies in outer space, and that seemed to be the field where the extremely sensitive properties of this amplifier could best be made use of.

In concluding a most interesting discussion, the Chairman threw in the inevitable questions: 'What does it cost?', 'do I have to rob the Crown jewels to make one of these most advanced devices?', and was assured that only 'commercial' ruby was involved, so that it could not be expensive.

The meeting closed with a special demonstration of appreciation to the author for the way in which he had presented his subject and dealt with the large number of points raised in the discussion.

C. E. W.

MEASUREMENT AND CONTROL

SELECTION, TESTING AND ASSEMBLY OF COMPONENTS

MANY of us, when we were younger and had more time to spare, may have built a radio set, perhaps from ex-Government components purchased in Lisle Street; and, although it was great fun, there must nevertheless have been times when we felt that our methods were perhaps a little crude, and applicable, at best, to a 'one-off' job. Producing batches of such things to a high standard of reliability, in real time, for sale in a competitive world, is quite another matter, and here there are several lines of conduct open to us.

The traditional way is to employ girls as data-processors who, with some tact and patience, can be suitably programmed to perform simple assembly and testing operations. The accompanying problems are well known. On the other hand, if large enough orders can be obtained for particular sets, our thoughts might fly to something similar to the mechanical automatic-transfer machines as used in the motor industry. Such large orders in the electronic assembly field are rare enough, however, and what is required is a simpler and more flexible method applicable to small or medium-sized batches.

An experimental transistor-controlled component selection and testing machine, designed to fulfil this need, was what Messrs. T. C. Cardwell, J. R. W. Smith and G. H. King set out to describe in their paper, read on the 26th April 1960 at Savoy Place, before a small but select audience, with Prof. A. Tustin in the Chair. An article based on the paper will be found on p. 436.

The paper had the great merit of brevity and it was, moreover, unpretentious, the authors emphasizing that their machine was assembled from relatively simple basic elements and was still only experimental.

The discussion which followed was opened by that doyen of the automation fraternity, Mr. J. A. Sargrove, who always succeeds in imbuing his subject with a youthful enthusiasm. After congratulating the authors on their achievement, he illustrated some alternative approaches to the problems of component testing and assembly with the aid of a series of interesting slides and films.

Peas of dubious colour

Mr. F. G. Swift, who was evidently in the same line of business as the authors, continued the discussion and praised the very able way in which several disciplines had been successfully integrated in producing the present machine. He pointed to the true virtue of the printed-wiring board, which lay in its promoting a new form of assembly and opened the way to a radical change in the whole concept of the design, manufacture, inspection, production control, presentation of engineering information, ordering, stocktaking and accountancy associated with the production of electronic circuits.

Mr. W. Fordham Cooper made some quite serious points in a rather amusing way, including an account of how the peas we eat for dinner were now automatically sorted, the ones of dubious colour being deflected into a waste bag. He was concerned, however, with what might possibly go wrong in the author's system, such as errors being inadvertently introduced in programming, and how one could subsequently keep track of information when there were no blueprints in file for reference, but only, perhaps, torn and tangled masses of punched tape.

These remarks provoked Mr. J. K. Webb, who appeared to be conversant with the behaviour of girls employed to punch and verify tape, to quote statistics of their error rate, which in this particular activity was only about 1 in 30000. He sought to allay Mr. Fordham Cooper's fears by pointing to methods which had been developed in other data-processing systems for coping with these human errors.

The authors had throughout the discussion replied to detailed questions, but they finally enlarged on some of the precautions which had been instituted. They frankly admitted, however, that they might still have much to learn when their machine had graduated from the experimental stage.

J. K. W.

VISIT TO HARLOW

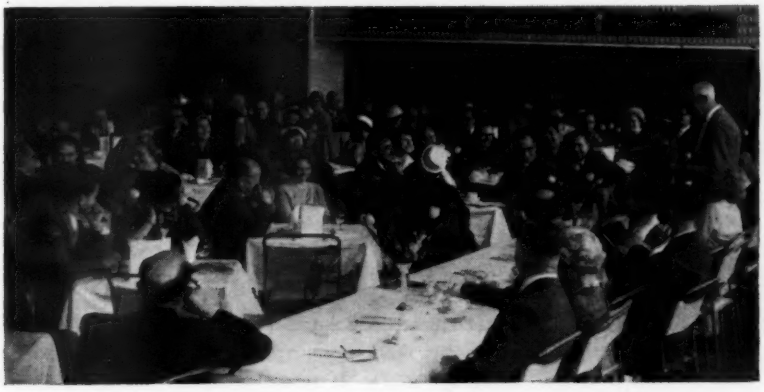
IN gloriously sunny weather, 87 members of the Section and their ladies visited Standard Telecommunication Laboratories at their new Harlow location on the morning of the 7th May 1960.

A group with an S.T.L. exhibit of radiocommunication using satellites

During the week, visitors from the worlds of science, industry and education had been received at the laboratories in the course of the 'open days' and, but for the preparations necessary for her wedding on the 6th May, H.R.H. Princess Margaret would have been a notable guest. Everything was

thus in good trim for demonstrations of some of S.T.L.'s current research programme.

After morning coffee, the party were shown a selection of the exhibits, covering a wide field of activities ranging from automatic spectrum analysis to communication systems using satellites.



Prof. Tustin thanks the hosts at the luncheon at Standard Telecommunication Laboratories

Floor-warming

At midday, cocktails and lunch were provided in the spacious restaurant; Mr. T. R. Scott, the managing director, presided and made a short speech of welcome. He explained why it had never been possible to receive such parties at their old Enfield premises. He mentioned that the present new buildings at Harlow stood in 17 acres of ground, had a gross floor-space of 100000 ft^2, and employed over 400, including 300 technical people—physicists, chemists, engineers and technical assistants.

There were several interesting architectural features about these modern buildings, which included electrical floor-heating supplemented by convectors. The essential job of the laboratories was to acquire new knowledge and 'know-how' in telecommunication and its allied fields, to enable general communication to become cheaper and more widespread. Such work extended from materials to components, from components to devices, from devices to systems, and from systems to the planning of their world-wide use.

The Section Chairman, Prof. A. Tustin, replied. He thanked Mr. Scott and all concerned for their hospitality and praised the excellence of the exhibits, set as they were in such fine surroundings.

Mr. L. E. White, Chief Liaison Officer of Harlow Development Corporation, then very competently outlined the development of Harlow New Town and its various features, in preparation for the afternoon tour in coaches. Two Harlow Development Corporation officials, Mrs. J. Long and Mrs. M. Porter, served as guides, and members thus obtained a clear picture of the realization of this interesting and practical social experiment.

Following the tour, the party gathered for tea at the Cock Hotel, Epping, and dispersed after what was generally agreed to be a very successful day's outing. G. A. V. S.

UTILIZATION

SUMMER VISIT TO OXFORD

It was Friday the 13th May 1960 and pouring with rain when most of the members started from their homes to travel to Oxford. However, shortly before 11.30 a.m., when the Visit was due to begin, the Section Chairman, Mr. T. E. Houghton, had discarded hat and coat in favour of umbrella, and the rain stopped. The Visit started with lunch as guests of Morris Motors Ltd., Cowley, where Mr. D. Francis welcomed us with a promise of a 2½-mile walk in which we would see cars being assembled at the rate of one every 45 seconds. Mr. Francis, in his short speech, was kind enough to extend a welcome to other Sections of The Institution, should any decide to hold a similar meeting in the district.

Bees round a hive

During the tour of the works, we were shown round by apprentices and official guides. We first saw the bodies of the Minicar being degreased, rust-proofed and painted. These then joined the main assembly line, where every car body met its 'heart and limbs'—engine, gearbox, transmission, front and rear axles, all as one assembly. The continuously moving conveyor; mechanical handling; teams of men, mostly young, working on a car like bees round a hive; fitting tubeless tyres; white-coated inspectors; close attention to detail—these were some of the impressions that one gained in the factory. It was interesting to see disabled people in a department doing special pre-assembly work for the higher-priced cars with walnut-faced instrument panels.

After assembly, cars did an equivalent of a 3-mile road test on special roller test apparatus. In another factory, we saw upholstery being made. We continued our walk down the main assembly line of the 1½-litre cars. Here the bodies met engine/gearbox assemblies, with all the remaining parts as

separate items arriving at various stages along the assembly line. We were impressed by the small amount of storage of components along the line and the need for accurate planning and control of materials. We learnt that the rate of assembly

Utilization Section Dinner-Dance at Oxford, 13th May 1960
On the left are Mrs. Vaughan Harries and Miss H. W. Turner; on the right Mr. and Mrs. Houghton

relies on the regular delivery of parts from other factories. In some cases, only half a day's stock is carried.

In the evening we attended a dinner-dance at the Randolph Hotel as guests of the Southern Electricity Board. In a brief speech, Mr. R. R. B. Brown, Chairman of the Board, welcomed us and expressed the hope that the meeting would be successful. Members' acclamation after Mr. Houghton's words of appreciation and thanks emphasized that a good start had been made. The evening was much enjoyed, particularly by a member and his lady from Yorkshire who were most successful in winning spot prizes.

St. John's gardens

On Saturday morning, the 14th, after a leisurely breakfast, the ladies were met by guides from the City of Oxford Publicity Board for a walking tour of the colleges. In warm sunshine, they found time to see many of the colleges and to enter some of them, visiting the chapels, libraries and dining-halls. It was interesting to note the various styles of architecture and to be reminded of the many famous links with history. The beautifully kept gardens were much admired, especially those of St. John's.

Some ladies climbed the numerous steps to the cupola of the Sheldonian Theatre, whence they had an excellent view of Oxford, looking magnificent on a May morning.

Meanwhile, the members and one lady visited the Clarendon Laboratory, where we were welcomed by Prof. B. Bleaney, who gave us a brief survey of the history of the laboratory and outlined the work being done. The number of students and graduates doing research work had increased about ten-fold between the years 1939 and 1959. Unfortunately, the building programme had not kept pace, and all were now working in very cramped conditions. This did not appear to have damped the enthusiasm of those who were kind enough to explain their work and equipment in use.

One of the subjects of special interest was a combination of low-temperature and nuclear physics. A particle was first cooled with liquid helium; it was then excited at a very high frequency, which increased its temperature. Maintaining the excitation, this increase was nullified by more cooling with liquid helium. On removal of the excitation, yet further cooling was produced. This method had achieved temperatures as low as $1{\cdot}2 \times 10^{-6}$° K.

The majority of the experimental equipment was made in the laboratory's own workshops, comprising fitting, machining and glass-blowing departments. These were staffed by enthusiasts whose work demanded a high standard of accuracy and unfailing patience when confronted with frequent modifications. Special plants for handling both liquid hydrogen and liquid helium had been installed.

In an experiment employing magnetic resonance, excitation was controlled to an accuracy within 1 part in 10^6. It was essential that the power supply for the very high magnetic fields should be free from ripple. Despite modern developments, the laboratory found the answer in two ancient 1000 kW 460 volt d.c. generators driven in tandem by an induction motor, plant once the property of Manchester Corporation.

The afternoon had been left free. Some members spent it on the river, others on a quiet drive into the surrounding country, others shopping, and some, perhaps, just resting.

In the evening, together with some of our hosts, we went to the New Theatre and enjoyed a performance of a musical play by Terence Rattigan—'Joie de vivre'.

Wooden mousetrap

On Sunday morning, the 15th, in brilliant sunshine, we journeyed by coach to Sulgrave Manor in Northamptonshire. After a halt at Banbury for coffee and a 'near miss' through the entrance gates, we were met by the Warden, who acted as our guide. Sulgrave Manor, the home of the ancestors of George Washington, is unique in that it celebrated 100 years of peace between Great Britain and the United States.

We were impressed by the compactness and comparative smallness of the house. At least one member probably remembers the lowness of the door when entering the hall. The house contained a fine collection of period furniture which was beautifully maintained and much admired, particularly a spinet and the four-poster beds with hand-embroidered counterpanes. The kitchen was equipped with all manner of fascinating articles designed for handling really large joints. Among the ancillaries was a wooden mousetrap operated by a tilting platform which tripped a solid block of wood to crush its victim.

From the garden, which was not large, in keeping with the small manor house, we were able to study the Washington coat of arms in a spandrel of the main doorway. The three mullets and two bars were said to have inspired the 'Stars and Stripes' of the United States flag. This flag and the Union Jack were fluttering from their respective masts in the morning breeze. While some of us admired the well kept yew hedges

and flowering shrubs, our enthusiastic amateur photographers were concentrating on measurements of light and depth of focus.

It seemed all to soon that we were back in the coaches and returning to Oxford, where the weather was deteriorating after being excellent during the whole meeting.

In a concluding speech after lunch, the Chairman thanked the Past-Chairmen and Vice-Chairmen and their Ladies for their support, and expressed great pleasure at having enjoyed the company of all present. On behalf of us all, he thanked the Institution staff for the work done in organizing so successful a Summer Visit. J. T.

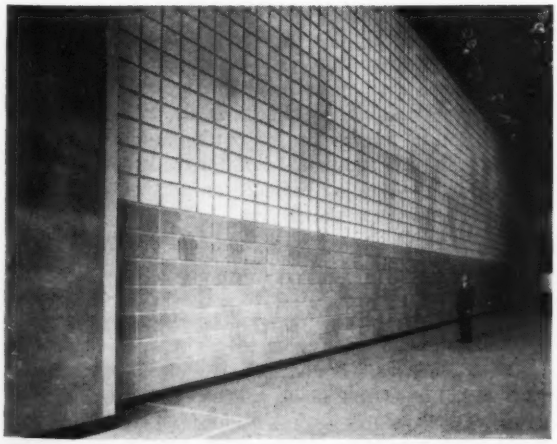
LONDON REPORT

Europe's largest television studio

Following the Annual General Meeting at Savoy Place on the 19th May 1960, with the President in the chair, a most enjoyable lecture at a quite exhilarating pace was given by Dr. A. M. Spooner, Head of Television Broadcasting Dept. (Engineering Division), Central Rediffusion Services. The new Associated-Rediffusion studio 5 at Wembley, soon to be brought into service, was exceptional in several ways. Having a floor space of 14000ft^2, a length of 140ft and a width of 100ft, it was extremely capacious. Dr. Spooner pointed out that this introduced disadvantages as well as obvious advantages. Not always would productions need such ample space, and he described how it would be possible to divide the one large studio into two utterly separate and similar units.

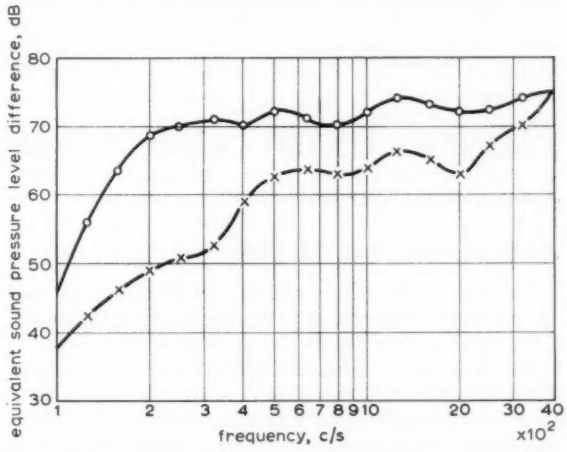
The partition

A great difficulty associated with such a division was to achieve adequate airborne and impact noise isolation between the two studios. This formidable obstacle had been overcome by the development of a most ingenious, movable, soundproof partition (Fig. A), coupled with a well designed interruption in the studio floor. The soundproof partition was in two identical halves, each half weighing 25 tons, and the whole structure was lifted vertically by electric motors in some 30 minutes. When raised, cameras saw no obstruction up to a height of 30ft over the whole of the studio area. Scenery could be 'flown', as in a theatre.



A *The soundproof partition lowered*

To establish the degree of sound separation with the partition lowered, the National Physical Laboratory had carried out extensive measurements in the studios. The airborne-noise test had consisted of originating in one studio loudspeaker-emitted 'warble' tones over the range 100–3200c/s at



B *Sound insulation between the two halves of the new studio 5*
—o— studio 5A to studio 5B (Wembley)
—×— studio 2 to studio 1 (Television House)

a mean output level of 200 watts, the measuring apparatus being located in the other studio.

The impact-noise test had employed a machine placed 2ft from the partition in one studio, the level of conduction being observed in the other. This machine had been constructed with five in-line hammers, each weighing 500g, spaced 40cm apart. The time interval between impacts had been 0·1sec, the hammers falling through a striking distance of 4cm. It had been possible to hear only a faint ticking through the partition when this apparatus had been operating. The attenuation through the partition is illustrated in Fig. B, which also shows for comparison the results for two individual studios elsewhere. A recording of several 'warble' tones, played to the audience, proved both amusing and eerie.

Production control

The lecturer described the comprehensive production, control and technical facilities which were disposed in a two-level

area extending the length of the studio. The ground-floor area contained dual 4-camera control equipment and other facilities; the first floor had dual production-control rooms, sound-control rooms and lighting-control areas. These could function as separate studio-control units when the soundproof partition was lowered. When the studio was operating as one large floor, master control was vested in one group.

The production-control rooms were equipped with 21in. monitors and the usual comprehensive studio communication system. As well as the usual facilities, the sound-control consoles incorporated the sound patch panels which so often were located in cubicles apart from the sound mixer, a most interesting feature. Studio sound fold-back was available. The total lighting load was 500kVA, and the lamps were carried on barrel fixtures by remotely controlled power-operated hoists. Lighting patterns were set up on the lighting consoles, which also incorporated dimmer facilities.

The studio could operate on 405, 525 and 625 lines, and the video spectrum had been extended to 6Mc/s to anticipate a possible use of this bandwidth with 625 lines. Provision had been made for a 60c/s power supply for use with 525 lines, for obvious reasons. If it were desired to record on video tape at 525 or 625 lines, the production could be either on 405 lines for home transmission and converted to the higher standard, or produced at the recording standard and converted down to 405 lines.

The lecture closed with a short film which, by speeding up, raised the soundproof partition at a record rate. Among other features shown, the film brought out the simplicity of the lighting fixtures and the ease of conversion from one-studio 8-camera operation to two-studio 4-camera operation.

The President thanked Dr. Spooner for his lecture, which had been given in a most clear manner, and commented that the noise recording had aptly illustrated the present conditions in the Institution building. Sir Willis Jackson called on the audience to applaud not only the lecturer, but also the lecturer's colleagues present in the Theatre, whom Dr. Spooner had warmly mentioned. R. C. H.

News from the Centres

SCOTTISH CENTRE

Annual General Meetings

THE 1959–60 Session concluded its formal business with the Annual General Meetings of the Centre, the three Sub-Centres and the Electronics and Measurement Group.

The South-East Scotland Sub-Centre, in Edinburgh, followed its business meeting with the customary short papers by a Graduate and Student Section member, and a senior member. Mr. D. Goodwin, presented a shortened version of his paper on 'Pinhole detection in sheet steel', previously given before the Graduate and Student Section, and Mr. A. A. B. Martin gave a talk, illustrated by excellent coloured slides, on some architectural features observed while touring France.

In the North and South-West Scotland Sub-Centres, films were shown after the business meeting; while at the Centre meeting, this year in Dundee, Mr. Goodwin repeated his talk on pinhole detection.

At the meeting of the Electronics and Measurement Group in Edinburgh, Mr. M. J. L. Pulling, Chairman of the Electronics and Communications Section, addressed the members and welcomed the formation of the Group; following the meeting, Mr. J. Stewart, the Chairman of the interim committee, opened a discussion on 'Does the flow of technical papers assist or retard progress?' Mr. Stewart had assembled a stack of periodicals about 2ft high which represented the monthly reading matter for a typical research worker in the light-current field; although there was a very lively discussion, no one was able to give a decisive answer as to how this material could best be assimilated.

The Centre Chairman elected for the 1960–61 Session is Mr. R. B. Anderson, and he will be supported by the three Sub-Centre Chairmen, Mr. I. S. Fraser in the South-East, Mr. L. F. Dorward in the North and Mr. W. L. Kidd in the South-West; Mr. J. Stewart will continue as the first formal Chairman of the Electronics and Measurement Group.

Spring at Pitlochry

Although the Centre was looking forward to the Institution Summer Meeting in Scotland, it was decided to hold the Spring Meeting of the Centre as usual at Pitlochry during the week-end of the 20th–23rd May 1960. The Hutcheson–Winning Golf Trophy was played for on the Saturday morning, the winner being again Dr. J. Jamieson, with Mr. J. K. Moffat of Pitlochry as runner-up.

In the afternoon, a visit to the small Cuaich induction-generator power station provided an excuse for a drive through magnificent Highland scenery with tea at Dalwhinnie at the invitation of the North of Scotland Hydro-Electric Board. In the evening, an excellent presentation of Noel Coward's 'Private lives' was seen at the Pitlochry Festival Theatre, and on Sunday various putting and other competitions brought in a substantial sum for the Benevolent Fund. Once again, the meeting provided an admirable conclusion to the normal work of the session. E. O. T.

NORTH-EASTERN CENTRE

Annual Dinner-Dance

THE Annual Dinner-Dance was held in the Old Assembly Rooms, Newcastle upon Tyne, on the 1st April 1960, when the Chairman of the Centre and Mrs. H. Watson-Jones received 300 members and their ladies, together with friends. The toast of The Institution was proposed, in very witty style,

by Lord Coleraine. Mr. C. T. Melling, a Vice-President, suitably replied. Mr. A. T. Crawford, Immediate Past-Chairman, proposed the toast of the visitors, who included

Dinner-Dance of the North-Eastern Centre on the 1st April 1960
(left to right) Mr. and Mrs. Crawford, Mr. and Mrs. Watson-Jones, and Mr. Melling

the Deputy Lord Mayor and Mrs. Russell; the Sheriff, Mrs. G. Robson, and the Sheriff's Lady, Mrs. E. Murray; and Mr. J. A. Aked, Chairman of the Scottish Centre. Sir James Duff, Mayor of Durham City and Vice-Chancellor of the University of Durham, replied in his usual racy manner.

A.G.M. and Conversazione

During this, our Diamond Jubilee Year, we have had visits from many notable members of The Institution, and on the occasion of our Annual General Meeting and Conversazione we were pleased to welcome to the Centre Mr. S. E. Goodall, a Past-President. During the meeting, he was able to give members valuable information and assistance in their deliberations. It was agreed at the meeting that, in future, members would be free to attend the Annual Conversazione without payment or advance notice. It is hoped to let members of the Centre have printed copies of Mr. J. R. Beard's Jubilee Address in the very near future. W. H. C.

SHEFFIELD SUB-CENTRE

Dinner-Dance

It is a pleasure to report progress at any time, and this year's Dinner-Dance of the Sub-Centre, held on the 8th May 1960, gave special pleasure, because over £250 was raised for the Benevolent Fund. It is difficult to see how the success of this annual event can be increased much further, as the dance floor of the largest hotel in Sheffield was filled to capacity. (The story is the same with the Faraday Lecture, when the Sheffield City Hall is filled annually to capacity to give one of the largest audiences [2300] for the Lecture throughout the whole country.)

At the Dinner, the top-table company consisted of the Chairman and Mrs. F. G. Tyack, the Senior Vice-Chairman and Mrs. E. J. Lilleker, the Junior Vice-Chairman and Mrs. G. L. Mason, Mr. and Mrs. A. Haddock, Miss Monica Tyack and Mr. G. Koopman.

The orchestral playing during the Dinner was most pleasant and added greatly to the dignity of the occasion.

During the Dance, 'Ernie (Jun.)' made 'his' debut. 'He' appeared to be an offspring of the Graduate Section family, but had been so well brought up that 'he' could be trusted to select the raffle prize-winners with complete impartiality.

The support which the Sub-Centre receives from electrical firms is most gratifying, and the prizes given by them raised £165 of the £250.

Annual General Meeting

The Sub-Centre A.G.M. was held on the 18th May 1960, and these officers were elected for the coming year: Mr. E. J. Lilleker, Chairman; Mr. G. L. Mason, Senior Vice-Chairman; Mr. J. W. Spooner, Junior Vice-Chairman; Mr. F. Seddon, Hon. Treasurer; and Mr. J. E. Caldwell, Hon. Secretary.

Mr. G. S. C. Lucas, a Vice-President of The Institution, was a very welcome visitor to this meeting, during which he presented an Institution prize to Mr. T. Taylor, who is now in the Royal Air Force. The prize was for exceptionally high marks gained in the Higher National Certificate examination at Chesterfield Technical College.

Where to in life

The Graduate and Student Section A.G.M. was held on the 4th May 1960. Dr. J. Allison was elected Chairman and Mr. P. A. McInnes Hon. Secretary. Another year of marked progress was reported, with a considerable increase in membership. The Sub-Centre Chairman, Mr. Tyack, read a paper on 'Where to in life', and this created a very lively discussion in which almost everyone took part.

Annual Dinner-Dance of the Sheffield Sub-Centre on the 8th May 1960 at the Royal Victoria Hotel, Sheffield
(left to right) Mrs. J. E. Leeson, Mr. and Mrs. Tyack, Mrs. J. E. Caldwell and Mr. J. E. Leeson (Honorary Assistant Secretary)

News from the Centres (continued)

The Section is to be congratulated that their pioneering idea of a week-end technical conference has now been officially recognized by The Institution and that grants will be made in support of such conferences in future. Already three have been held, and each has consisted of three papers, visits to places of electrical interest and a healthy social side.

District Meeting

A District Meeting for members in North Lincolnshire was held at Grimsby on the 27th April 1960 and drew visitors from Sheffield, Leeds and Hull, making an attendance of 86.

J. W. S.

News from abroad

TRINIDAD AND TOBAGO JOINT GROUP

Annual General Meeting

THE Annual General Meeting was held on the 8th April 1960 at the Queen's Park Hotel, Port-of-Spain. The Officers and Committee are now as follows:

Officers:
Mr. K. W. Finch, M.I.E.E.—Chairman
Mr. A. H. Richard, M.I.C.E.—Vice-Chairman
Mr. J. G. S. Cumming, A.M.I.MECH.E.—Vice-Chairman
Mr. W. T. Boyd, M.I.MECH.E.—Immediate Past-Chairman
Mr. D. E. Key, A.M.I.C.E.—Programme Secretary
Mr. L. G. Felipes, A.M.I.E.E.—Public Relations Member
Mr. D. P. J. Holbrook, A.M.I.E.E.—Hon. Secretary

Committee:
Mr. H. D. Walden, A.M.I.E.E. (*ex officio*—Oversea Representative of the Council of the I.E.E.)
Mr. L. G. Dookhie, A.M.I.E.E.
Mr. C. Dupenois, A.M.I.C.E.
Mr. C. Farrell, A.M.I.C.E.
Mr. L. G. Felipes, A.M.I.E.E.
Mr. D. E. Key, A.M.I.C.E.
Mr. J. I. Macaulay, M.I.MECH.E.
Mr. R. I. Marshall, M.I.MECH.E.
Mr. A. I. H. Scott, A.M.I.MECH.E.
Mr. E. Taylor, A.M.I.E.E.

Earthquakes

On the 22nd April 1960, 33 members of the Joint Group were present when Dr. G. R. Robson, Head of the Imperial College of Tropical Agriculture Seismatic Research Unit, and Mr. D. E. Key read papers on Caribbean earthquake-resistant structures.

Both lecturers, while basing their talk on general principles, drew their illustrations from the Caribbean area. It was emphasized that the possibility of earthquakes was a factor which should not be discounted in designing buildings in the Caribbean in general and Trinidad in particular, especially buildings which have to provide accommodation for large numbers of people. After a lively discussion, a vote of thanks was proposed by Mr. R. E. K. Inniss.

D. P. J. H.

Factory electrification in Uganda

MOST of the coffee curing and hulling factories within the Uganda Electricity Board's area of supply are now fully electrified, and altogether over 75% of the total coffee crop is processed at electrified factories.

The main problem in the electrification programme for the cotton-processing industry is the heavy capital cost of making the changeover. However, as capital equipment becomes due for replacement, it is hoped that the existing prime movers will be exchanged for electrically powered machinery. In cotton zones where electricity has already become the major fuel utilized for ginning cotton, it has been proposed that the price per bale payable to ginners should be related to the cost of electricity consumed.

One of the chief advantages of electrification, in the view of proprietors of both coffee and cotton processing factories, is the improvement to works lighting which can be effected, with consequent improvements in efficiency and in the safety of employees.

About two-thirds of the total production of tea during 1959 was processed at partly or fully electrified factories. The Board also report an increase in the demand for electricity in maize milling and oil-seed crushing.

Many factories for the processing of agricultural produce are situated outside the larger towns, and the Uganda Electricity Board have laid emphasis on the electrification of these wherever possible.

Telex service with India

A NEW telex service between the United Kingdom and India, at present restricted to Bombay and Ahmedabad, was opened last month. The charge for calls up to three minutes is £3, and each additional minute or part of a minute costs £1. Hours of service are from 7 a.m. to 6 p.m. on weekdays and from 7 a.m. to 1 p.m. on Saturdays (British time).

It is expected that extensions to include subscribers in Calcutta, New Delhi and Madras will be arranged later.

OVERSEA ATTENDANCE REGISTER

DURING the period 16th May to 17th June 1960, these members called at the Institution building and signed the Attendance Register of Oversea Members:

ANDERSON, R. G. (Barakat, Sudan)
BARDENS, A. T. B. (Hong Kong)
BUTTERLY, P. J. (Murray Hill, New Jersey)
DAVIES, J. D. D. (Aden)
DUFF, J. C. (Takoradi, Ghana)
FITTON, T. W. E. (Kaduna, Nigeria)
GIDWANI, M. H. (Bombay)
HAFFNER, V. A. (Lagos, Nigeria)
KORAM, E. M. (Accra, Ghana)
LOW, S. L. (Singapore)
MEADE, J. (Lagos, Nigeria)
MILLER, W. L. E. (Hong Kong)
RAMSBOTHAM, W. A. M. (Singapore)
REID, J. E. (Calcutta)
SINK, H. B. (Durban)
SKERREY, C. E. (Nicosia, Cyprus)
SMITH, J. E. (Uganda)
STOCK, J. M. (Uganda)
TEN KLEY, W. B. (Wellington, N.Z.)
THOMAS, G. (Lagos, Nigeria)
THOMAS, L. W. (Washington, D.C.)
WILLIAMS, J. W. M. (Nairobi)

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*R. W. STEEL

* *Past-Chairman*

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Asst. Secretary: R. W. SHIELD, 152 Edge Hill, Darras Hall, Ponteland, Newcastle upon Tyne

North-Eastern Measurement and Electronics Group

Chairman: C. C. BAXENDALE

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